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UNIVERSITY OF CALIFORNIA.

BIENNIAL REPORT

OF THE

PRESIDENT OF THE UNIVERSITY

ON BEHALF OF THE BOARD OF REGENTS,

TO

His Excellency the Governor of the State.

1888.

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1889.

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REPORT.

To his Excellency R. W. Waterman, *Governor of the State of California:*

Sir: In accordance with the provisions of the Political Code, I have the honor to present the report of the Regents on the progress, condition, and wants of the University of California during the past two years. This document also includes the biennial report of the Dean of the Faculty of Letters and of the Faculties of Science, reports from the heads of the various departments at Berkeley, and from the Director of the Lick Observatory, and reports from the Deans of the affiliated professional colleges; thus giving an insight into the detailed workings of every part of the University.

I have transmitted these reports in full, though it is not customary to do so, because I wished to give in their own language the views of these gentlemen respecting the wants and the policy of the departments under their charge. While I do not always indorse their views, it seemed to me they were entitled to an opportunity to express them, and to have a candid hearing.

In my own report, I have noted what I thought the most pressing wants of the University, but I desire to say that we do not ask for any special appropriations, but we indicate these wants partly to show how the efficiency of the University is hampered by its lack of facilities, and partly in the hope that some generous citizen may come to our relief, and build himself an indestructible monument while he helps the cause of good education.

I also send with this document the reports of the Secretary of the Board of Regents for the two fiscal years ending, respectively, June 30, 1887, and June 30, 1888, and I beg to refer you to these reports for further information respecting our material affairs, such as the state of the finances and the condition of the buildings and grounds. The Secretary's reports contain other matters where the action of the Board of Regents affects directly the internal working of the University, such as changes in the staff of instruction, degrees granted during the past two years, records of donations to the library and museum, which are omitted here to avoid repetition.

DETAILS CONCERNING INSTRUCTION.

Turning, for the present, to the consideration of the colleges at Berkeley, the report of Professor Irving Stringham, Dean of the Faculty of Letters and of the Faculties of Science, takes a more general view of affairs at Berkeley than the reports of the Professors in charge of departments, and gives the statistics of attendance, and of the courses of study there, and some of the general features of student life. For the more minute particulars, I respectfully refer you to the published Registers of the University for the years 1886–7 and 1887–8, which are transmitted herewith.

CONDUCT AND SCHOLARSHIP.

The internal condition of the colleges at Berkeley is excellent; the relations between the professors and the students are friendly, and there is no friction between the classes. The standard of scholarship is fully maintained, or even somewhat advanced from that of two years ago, for although there have been no material changes in the curricula during this period, the inclination is constantly towards better methods of study, requiring sounder and more thorough conquest of the subjects in hand. In this way, without change of curriculum, the scholarship is steadily improved.

PHYSICAL CULTURE.

The Board of Regents in their estimate of expenditure for the present year allowed $3,000 for the establishment of a Department of Physical Culture. This has been organized by the appointment of Dr. F. H. Payne as Director, and Mr. Walter Magee as Assistant. The intention is that every young man shall undergo a thorough medical examination by Dr. Payne when he enters college. The Doctor will then prescribe the form and quality of exercise necessary for his sound physical development, and Mr. Magee, who is an experienced instructor in gymnastics, will superintend the exercise on the floor. The young men will be formed in squads of about twenty, and all exercise will be conducted under the guidance of Mr. Magee. The regular course consists of half an hour of active exercise on the floor every day. Our object is to make perfectly developed men, and not athletes. The students are delighted with the prospect, and have taken hold of the work with good will. The Faculty have also caught some of the spirit, and have formed an exercise class among their number. The young ladies, wishing to share the same benefits, have formed a class, which meets on Wednesday and Friday afternoons, also under Mr. Magee's training.

ATTENDANCE.

By turning to the Dean's report, it will be seen that the attendance at Berkeley is steadily increasing; the figures are as follows: In 1884–5, two hundred and forty-one students; 1885–6, two hundred and fifty; 1886–7, two hundred and eighty-eight; 1887–8, three hundred and six; while in 1888–9, there will be somewhat over three hundred and fifty. An inspection of the Dean's figures will show that the advance has been on the English and scientific side of the University, mainly in the Course in Letters and Political Science (the English course) and the College of Mechanics.

AGE OF STUDENTS.

The average age of students has advanced slightly though not materially during the last seven years. The annexed table gives the—

AVERAGE AGE, AT DATE OF ADMISSION, OF STUDENTS ENTERING REGULAR COURSES (FRESHMAN CLASS) OR COURSES AT LARGE.

YEAR.	No. of Students Concerned	AVERAGE AGE.	
		Years.	Months.
1882	-------	18	1.7
1883	-------	18	6.6
1884	-------	18	7.2
1885–86	60	18	6.9
1886–87	77	18	7.9
1887–88	99	19	6.5
1888	102	18	7.9

PLACES OF ENTRANCE EXAMINATIONS.

In June, 1887, a change was made in the places of holding entrance examinations, by the substitution of Grass Valley and Chico instead of Marysville. Below is a tabular statement of the number of applicants in June, at each place, during the last three years. The September examinations are held at Berkeley only:

PLACE.	NUMBER OF APPLICANTS.		
	Matriculation.	Law.	Preliminary.
In June, 1886:			
Berkeley	38	-------	2
Los Angeles	7	-------	5
Marysville	1	-------	2
In June, 1887:			
Berkeley	37	1	1
Los Angeles	10	-------	7
Chico	1	-------	2
Grass Valley	6	-------	5
In June, 1888:			
Berkeley	60	4	1
Los Angeles	13	1	3
Chico	-------	-------	2
Grass Valley	2	-------	-------

CHANGES IN THE REQUIREMENTS FOR ADMISSION.

Changes have been made in the entrance requirements, as indicated below; the numerals refer to Subjects described in the University Register, and numbered as follows: 1, English; 2, Arithmetic; 3 (*a* and *b*), Algebra; 4 (*a* and *b*), Plane Geometry; 5, History and Geography; 6, Latin; 7, Latin; 8, Greek; 9, Greek; 10, Ancient History and Geography; 11, Physics; 12 (*a*), Chemistry; 12 (*b*), Botany; 12 (*c*), Physiology; 12 (*d*), Mineralogy; 12 (*e*), Plane Trigonometry; 12 (*f*), Free-hand Drawing; 13, English History; 14, English.

I. For the LITERARY COURSE;—In 1886, the requirements were Subjects 1, 2, 3*a*, 4*a*, 5, 6, 7, 10, and any two of the Subjects in 11 and 12.

In 1887 and afterwards, Subjects 1, 2, 3*a*, 4*a*, 5, 6, 7, 10, 13, and 14.

II. For the COURSE IN LETTERS AND POLITICAL SCIENCE;—In 1886, the requirements were Subjects 1, 2, 3*a*, 4*a*, 5, 6, 7, 8, 9, and 10; or 1, 2, 3*a*, 4*a*, 5, 6, 7, 10, and any two of the Subjects in 11 and 12; or 1, 2, 3 (*a* and *b*), 4 (*a* and *b*), 5, 13, 14, and any two Subjects in 11 and 12.

In 1887 and afterwards, Subjects 1, 2, 3*a*, 4*a*, 5; and either 6, 7, 8, 9, and 10; or 6, 7, 10, 13, and 14; or 3*b*, 4*b*, 11, 12, and either 6 or 14.

III. For any of the five COURSES IN SCIENCE;—In 1886, the requirements were Subjects 1, 2, 3 (*a* and *b*), 4 (*a* and *b*), 5, 13, 14, and any two of the Subjects in 11 and 12.

In 1887 and afterwards, Subjects 1, 2, 3 (*a* and *b*), 4 (*a* and *b*), 5, 11, 12, and either 6 or 14.

Applicants were allowed to offer the requirements of 1887 in 1886.

The effect of these changes was to make Physics (Subject 11) prescribed for admission to any of the five Courses in Science, and for admission to the Course in Letters and Political Science by the third alternative group. Formerly in these cases, Physics was elective with the natural sciences of Subject 12. Furthermore, in the requirements for admission to the Courses in Science, and for admission to the Course in Letters and Political Science by the third alternative group, Latin (Subject 6) was made elective with English (Subject 14); and for admission to the Literary Course, English History (Subject 13) and English (Subject 14) took the place of two Subjects formerly selected by the applicant from Subjects 11 and 12.

Within the period covered by this report, no changes have been made in the requirements for admission to the Classical Course.

ADMISSION FROM APPROVED SCHOOLS.

A regulation was adopted by the Board of Regents March 4, 1884, providing that public schools may, upon application of the Principal, be examined by members of the University Faculty, and if the result be satisfactory, graduates of those schools may be admitted to the University without examination, under certain conditions. The plan has worked well, and the privilege was extended on May 8, 1888, to private schools. (See Secretary's report for June 30, 1888, page 45.) This plan has been of great benefit in closing the gap between the University and the schools. The High Schools have been ambitious to gain the privilege, and already six of them have come into line, viz.: those of Oakland, San Francisco, Berkeley, Alameda, Sacramento, and Stockton. We hope to add others to the list this year. A school may be accepted for part of our courses, if unable to maintain all of them. Thus schools having no classical courses may be accepted and enter their pupils at Berkeley for the English and scientific courses without examination.

It is an interesting question, what standing these accredited students maintain in the University after entrance, as compared with those who entered by examination. I add a—

TABLE SHOWING THE COMPARATIVE STANDING, DURING THE FRESHMAN YEAR, OF STUDENTS ADMITTED ON EXAMINATION AND STUDENTS ADMITTED ON RECOMMENDATION FROM ACCREDITED SCHOOLS.

HOW ADMITTED.	1884.		1885.		1886.		AVERAGE—THREE YEARS.	
	Number.	Grade.	Number.	Grade.	Number.	Grade.	Number.	Grade.
On examination	45	61.9	46	67.1	57	71.5	148	67.2
On recommendation	25	68.8	23	74.2	26	69.9	74	70.9

The maximum "grade" attainable was 95.

It is evident from these figures that the standing of those entering on diploma is little if any above the average of those entering by examination. Of course, no account is taken of those rejected at examination, the number of whom appears in a subsequent table. Statistics in our possession show: First, the difficulty of keeping the accredited schools up to our standard of scholarship; second, that those who pass examination without conditions are superior in attainments to the average of those entering by diploma.

APPLICATIONS FOR ADMISSION.

The next table shows the results for two years of all the applications for admission to the University.

TABLE SHOWING THE NUMBER, CLASSIFICATION, AND RESULT OF THE APPLICATIONS FOR ADMISSION IN 1887 AND IN 1888.

NOTE.—The upper figures on the left side of each column refer to young men, the lower to young women; the numbers on the right side are the totals.

	1887.							1888.						
	STATUS.				TOTALS.			STATUS.				TOTALS.		
	Regular Course, Freshman Class.	Course at Large.	Special or Graduate Course.	Limited Course.				Regular Course, Freshman Class.	Course at Large.	Special or Graduate Course.	Limited Course.			
I. ADMITTED TO THE UNIVERSITY	74 15 89	9 1 10	19 4 23	5 3 8	-------- --------	-------- --------	107 23 130	79 20 99	5 3 8	13 8 21	4 4 8	-------- --------	-------- --------	101 35 136
1. *On recommendation from approved schools*	33 10 43	3 0 3	1 0 1	0 2 2	-------- --------	37 12 49	-------- --------	24 18 42	-------- --------	-------- --------	0 2 2	-------- --------	24 20 44	-------- --------
a. Alameda High School	3 4 7	-------- --------	-------- --------	-------- --------	3 4 7	-------- --------	-------- --------	0 5 5	-------- --------	-------- --------	0 1 1	0 6 6	-------- --------	-------- --------
b. Berkeley High School	2 2 4	-------- --------	-------- --------	-------- --------	2 2 4	-------- --------	-------- --------	4 4 8	-------- --------	-------- --------	-------- --------	4 4 8	-------- --------	-------- --------
c. Oakland High School	11 1 12	-------- --------	1 0 1	0 2 2	12 3 15	-------- --------	-------- --------	6 7 13	-------- --------	-------- --------	0 1 1	6 8 14	-------- --------	-------- --------
d. Sacramento High School	2 2 4	-------- --------	-------- --------	-------- --------	2 2 4	-------- --------	-------- --------	1 1 2	-------- --------	-------- --------	-------- --------	1 1 2	-------- --------	-------- --------
e. San Francisco Boys' High School	14 0 14	2 0 2	-------- --------	-------- --------	16 0 16	-------- --------	-------- --------	12 1 13	-------- --------	-------- --------	-------- --------	12 1 13	-------- --------	-------- --------
f. Stockton High School	1 1 2	1 0 1	-------- --------	-------- --------	2 1 3	-------- --------	-------- --------	1 0 1	-------- --------	-------- --------	-------- --------	1 0 1	-------- --------	-------- --------

2. *On examination*	40 5 45	5 1 6	18 4 22	5 1 6	-------- --------	68 11 79	-------- --------	54 2 56	2 1 3	13 8 21	3 1 4	-------- --------	72 12 84	-------- --------
a. Without conditions	4 2 6	1 0 1	16 4 20	4 1 5	25 7 32	-------- --------	-------- --------	5 0 5	1 0 1	12 8 20	1 1 2	19 9 28	-------- --------	-------- --------
b. With conditions	36 3 39	4 1 5	2 0 2	1 0 1	43 4 47	-------- --------	-------- --------	49 2 51	1 1 2	1 0 1	2 0 2	53 3 56	-------- --------	-------- --------
3. *On credentials from other Universities*	1 0 1	1 0 1	-------- --------	-------- --------	-------- --------	2 0 2	-------- --------	1 0 1	3 2 5	-------- --------	1 1 2	-------- --------	5 3 8	-------- --------
II. Rejected	15 2 17	-------- --------	-------- --------	3 0 3	-------- --------	-------- --------	18 2 20	23 2 25	1 0 1	2 0 2	1 3 4	-------- --------	-------- --------	27 5 32
III. Applications withdrawn	-------- --------	-------- --------	1 0 1	2 0 2	-------- --------	-------- --------	3 0 3	1 1 2	-------- --------	2 3 5	1 2 3	-------- --------	-------- --------	4 6 10
Totals	89 17 106	9 1 10	20 4 24	10 3 13	-------- --------	107 23 130	128 25 153	103 23 126	6 3 9	17 11 28	6 9 15	-------- --------	101 35 136	132 46 178

ENTRANCE CONDITIONS.

It is a matter of great interest, especially to teachers, to know in what studies the applicants for admission are conditioned. I, therefore, add a—

Table Showing the Percentage of Applicants Conditioned (or Failing) in the Examination in each Subject of the Requirements for Admission.

Note.—In the fractions, the numerator shows the number of applicants conditioned, the denominator the total number of applicants taking the examination in the given subject.

No. of Subject.	Subject.	1887.	1888.
1	English	$\frac{13}{73}$ = 17.8 per cent	$\frac{21}{109}$ = 19.26 per cent.
2	Arithmetic	$\frac{24}{79}$ = 30.38 per cent	$\frac{20}{98}$ = 20.40 per cent.
3	Algebra	$\frac{25}{78}$ = 32.05 per cent	$\frac{39}{97}$ = 40.20 per cent.
4	Geometry	$\frac{24}{75}$ = 32.00 per cent	$\frac{50}{91}$ = 54.94 per cent.
5	United States History	$\frac{21}{76}$ = 27.63 per cent	$\frac{11}{94}$ = 11.70 per cent.
	Geography	$\frac{1}{89}$ = 1.25 per cent	$\frac{2}{93}$ = 2.15 per cent.
6	Cæsar	$\frac{5}{33}$ = 15.15 per cent	$\frac{10}{42}$ = 23.80 per cent.
	Cicero	$\frac{11}{32}$ = 34.37 per cent	$\frac{11}{39}$ = 28.20 per cent.
	Latin composition	$\frac{13}{32}$ = 40.62 per cent	$\frac{30}{40}$ = 75.00 per cent.
7	Cicero	$\frac{5}{14}$ = 35.71 per cent	$\frac{4}{20}$ = 20.00 per cent.
	Vergil	$\frac{5}{16}$ = 31.25 per cent	$\frac{3}{19}$ = 15.78 per cent.
	Latin composition	$\frac{4}{13}$ = 30.76 per cent	$\frac{13}{20}$ = 65.00 per cent.
	Latin at sight	$\frac{2}{16}$ = 12.50 per cent	$\frac{7}{20}$ = 35.00 per cent.
8	Anabasis	$\frac{2}{7}$ = 28.57 per cent	$\frac{2}{5}$ = 40.00 per cent.
	Greek composition	$\frac{3}{6}$ = 50.00 per cent	
9	Anabasis	$\frac{1}{7}$ = 14.28 per cent	$\frac{3}{4}$ = 75.00 per cent.
	Homer	$\frac{2}{7}$ = 28.57 per cent	
	Greek composition	$\frac{2}{6}$ = 33.33 per cent	
	Greek at sight	$\frac{1}{7}$ = 14.28 per cent	
10	Greek history	$\frac{1}{15}$ = 6.06 per cent	$\frac{5}{20}$ = 25.00 per cent.
	Roman history	$\frac{2}{17}$ = 11.76 per cent	$\frac{1}{22}$ = 4.54 per cent.
11	Physics	$\frac{16}{50}$ = 32.00 per cent	$\frac{21}{63}$ = 33.33 per cent.
12	Chemistry	$\frac{1}{15}$ = 6.06 per cent	$\frac{2}{23}$ = 8.69 per cent.
	Advanced chemistry	$\frac{0}{0}$ = ----------------	$\frac{8}{10}$ = 80.00 per cent.
	Botany	$\frac{0}{4}$ = 00.00 per cent	$\frac{3}{9}$ = 33.33 per cent.
	Physiology	$\frac{3}{30}$ = 10.00 per cent	$\frac{3}{33}$ = 9.09 per cent.
	Mineralogy	$\frac{0}{0}$ = ----------------	$\frac{0}{0}$ = -------------
	Plane trigonometry	$\frac{1}{3}$ = 33.33 per cent	$\frac{1}{4}$ = 25.00 per cent.
	Free-hand drawing	$\frac{0}{4}$ = 00.00 per cent	$\frac{0}{4}$ = 00.00 per cent.
13	English history	$\frac{8}{18}$ = 44.44 per cent	$\frac{2}{18}$ = 11.11 per cent.
14	English	$\frac{10}{39}$ = 25.64 per cent	$\frac{24}{59}$ = 40.67 per cent.

WANT OF PREPARATORY SCHOOLS.

One very pressing want of this University is more feeders and better feeders in the remote parts of the State. Nothing would tend so much to increase the number of students, and raise their scholarship, as the improvement of the preparatory schools now existing, and the establishment of new ones. The lack of these is one reason why the large majority of the students come from around the bay. It is because the schools are so much better there than anywhere else, except in Stockton and Sacramento.

A glance at the history of the University will reveal some curious facts connected with this subject. In 1878–9 the number of students at Berkeley reached a maximum of three hundred and thirty-two; from this point it steadily declined to two hundred and fifteen, in 1882–3; from that minimum it has advanced again, year by year, till in 1888–9 it will exceed three hundred and fifty—the largest number ever within our walls.

The causes of this movement are not hard to find. They are, first, the gradual raising of the entrance requirements of the University; and second, the separation of the High Schools from the State school system, in 1879, by the new Constitution. This remarkable provision was followed by a decline in the advanced schools, which were thus thrown on the charity of local Boards of Education. This opposition to High School education was, perhaps, natural in a new State just redeemed from the wilderness, but those times have passed by, and the period has come to remedy the damage then inflicted on our public school system, and to make such provision, as can be made under existing conditions, to so unify the State system that any boy may obtain in the public schools a sound preparation for the University.

The question might be raised whether the University was not too high rather than the schools too low. But a glance at our course of study as compared with the curricula of other colleges of reputation (see President Holden's Biennial Report, 1886, table opposite page 18), will show that this is not so. In some branches of study, notably in mathematics and languages other than English, our entrance requirements are hardly up to those of the best eastern colleges. Now, the honor of the State is involved in this as well as the credit of the University. We must maintain an educational institution of the first order on this Coast. We cannot afford to let our boys and girls go by our doors to the eastern colleges, because we are unable to give them a first class education here.

But there are other reasons, even more cogent, why we must keep up our standard. The grade of the public schools depends directly on the grade of the University. If we should lower our standard of education, the public schools would be content with what we prescribed as essential, and would conform to the new standard. Now, the general intelligence of the people rests largely on the influence of the school. When the schools are poor the people are generally ignorant. So that the welfare of the whole community is ultimately involved in the maintenance of our standard. We must try to keep abreast of the best American colleges.

Assuming, then, that the State expects its University to keep in the front rank, let us turn to our institutions of secondary education, and we find they form three distinct groups, without any organic connection. First, the Primary and Grammar Schools; second, the Normal Schools, partly overlapping the Grammar, but not reaching the University; and third, the High Schools, which are local institutions, cut off from State aid and varying in quality according to the community they represent, and with very different courses of study. Over all these is the University with no power over any of them and having direct connection with only six High Schools through its system of entrance on diploma.

The University has thus accomplished by moral force what it had no legal power to do; it has forged a link of connection with the public school system; and now we want to go on and bring all the schools in direct connection with us. First, the Normal Schools should be graded up to University requirements; thus two objects would be accomplished. The graduates of the Normal Schools would then be fit to teach the lower grades of the High Schools; and secondly, the University could establish a chair of Pedagogics and train those Normal graduates who entered the University in the higher methods of instruction, while now the graduate of the Normal School is unable to pass our entrance requirements without private instruction.

In addition the various advanced schools, which now pass under the name of High Schools, should be directly connected with the University. If unable to support a classical course, they should be compelled to maintain such an English and scientific curriculum as would lead up to that side of the University. And here is the answer to the statement sometimes made, that a preparation for the University is of no value for ordinary life. This is, perhaps, in some measure true of the classical courses, but certainly not of the requirements for our English course and our scientific colleges, where nothing is required which is not of value to any intelligent citizen.

I believe, then, that such a school, connecting with the English and scientific courses of our study, should be established and maintained in every town having over two thousand five hundred inhabitants, and, if possible, that in the more sparsely populated parts of the State, county schools should be provided for of the same grade. Then, as the number of children increased, classical courses could be added; but even without these, the whole State would be brought into direct contact with three fourths of the instruction given at the University.

CONFERENCES WITH TEACHERS.

The staff of instruction at Berkeley has sought to bring itself into harmony with the teachers of the State, for the promotion of these and similar reforms, and to this end a series of conferences between the two bodies was proposed. The first of these meetings was held at Berkeley on the twenty-fourth of April, 1886, of which mention will be found in the last Biennial Report of the President of the University, page 31.

On the thirteenth of November, 1886, an interesting conference on the teaching of English and of mathematics (including physics) was held at the University. About two hundred and fifty educators from various parts of the State attended this meeting.

The following resolutions were adopted as the sense of the Conference in English:

Resolved, That constant drill should be had in our Primary Schools in the careful use of language, to the end that the vocabulary of the child shall be enlarged and his language enriched.

Resolved, That the study of the English language should begin, not with abstract definitions and rules, but with careful practice of the language itself, and that in this the chief purpose should be to cultivate in the child the ability to discern the power and the office of each word, and the relation of words to one another, and thus, in the end, to enable him to determine what words to use and how to use them.

Resolved, That the science of the English language, including in its elementary form the analysis of the English sentence, the distribution of its parts, the actual changes of word forms, real agreements between words, and the laws applicable to the same, should be carefully taught in the Grammar Schools of the State.

Resolved, That the Conference reserves for further consideration its judgment upon the question as to the time and condition under which text-book instruction in the subjects covered by the preceding resolutions shall begin in the Grammar School course.

Concerning mathematics the following resolutions were unanimously adopted:

First.—That it is the sense of this meeting that the beginning of the study of geometry should precede that of algebra.

Second.—That the arithmetic should be completed at the end of the Third Grade, and that a short review be held during the last six months of the First Grade year.

Third.—That the study of some elementary forms of geometry should be begun in the Second Grade of the Grammar School.

In physics, it was determined that the cost of necessary apparatus for preparatory instruction might be as low as $100, and it was voted that the schools represented were able to secure this minimum amount of apparatus, and, in general, to meet the University entrance requirements in physics.

No Conference was called in 1887, its place being more than filled by the twenty-first annual session of the California Teachers' Association, which was held at the University during the four days beginning with the twenty-seventh of December. The good results of such meetings are obvious.

CHANGES IN THE TEACHING STAFF.

Complete statement of the changes that have taken place in the teaching staff of the University during the last two years will be found in the Annual Report of the Secretary to the Board of Regents for the year ending June 30, 1887, p. 33, and in the Annual Report of the Secretary for the year ending June 30, 1888, pp. 5, 7, 9, 14, 22, 25, 26.

Below will be found complete statistics of the number enrolled on the staff of instruction during the last nineteen years.

Table Showing the Number of Professors, Assistant Professors, Instructors, and Assistants in the Colleges at Berkeley during each Academic Year—Compiled from the Annual Registers.

Year.	Professors.	Asst. Professors.	Instructors.	Assistants.	Totals.
1869-70	8	1	1	--------	10
1870-71	10	1	1	1	13
1871-72	10	2	1	--------	13
1872-73	12	1	4	--------	17
1873-74	11	1	7	3	22
1874-75	14	1	9	6	30
1875-76	15	--------	16	7	38
1876-77	15	--------	15	6	36
1877-78	16	--------	18	4	38
1878-79	15	--------	19	3	37
1879-80	14	--------	18	3	35
1880-81	14	--------	16	6	36
1881-82	12	--------	16	--------	28
1882-83	13	--------	15	--------	28
1883-84	15	--------	15	--------	30
1884-85	16	1	13	5	35
1885-86	18	2	12	6	38
1886-87	20	5	10	7	42
1887-88	18	6	9	10	43

NEW BUILDINGS.

The formal transfer of the Lick Observatory to the University was completed in June, 1888.

The following new buildings have been erected on the University grounds during the two years ending June 30, 1888:

(*a*) An addition to the Harmon Gymnasium, built at a cost of $2,556 28, by State appropriation; and (*b*) The United States Agricultural Experiment Station building, at a cost of $10,000. Of this latter amount, $7,000 was derived from the general fund of the University, and $3,000 from the United States appropriation; this building is now occupied by the Agricultural Department exclusively.

DONATIONS TO THE LIBRARY AND MUSEUMS.

The donations to the Library and Museums during the last two years will be found recorded in the Annual Report of the Secretary for the year ending June, 1887, pp. 55–66, and for the year ending June, 1888, pp. 98–118.

UNIVERSITY PUBLICATIONS.

Among the publications of the University within the past two years may be mentioned the following, copies of which are transmitted herewith:

On the Losses in Roasting Gold Ores and the Volatility of Gold, by Professor Christy.

Cardinal Guala and the Vercelli Book, by Professor Cook.

Report on Physical Training, by Lieutenant Harrison.

A New Hydraulic Step, by Professor Hesse.

Testing Materials, by Professor Hesse.

Report of the Professor of Agriculture, for the year ending June 30, 1887, by Professor Hilgard.

Report of Experiments on Methods of Fermentation and Related Subjects during the years 1886–87, by Professor Hilgard.

The Art of Life—Commencement Address, 1887, by President Holden.

List of Recorded Earthquakes of California, Lower California, Oregon, and Washington Territory, by President Holden.

Suggestions for Observing the Total Eclipse of the Sun on January 1, 1889, by Professor Holden.

Building Stones of California, by Professor Jackson.

The Oaks of Berkeley and Some of Their Insect Inhabitants, by Mr. Rivers.

List of Printed Maps of California, by Mr. Rowell.

References for Students of Miracle Plays and Mysteries, by Mr. Stoddard.

The Present and Future of the University—Commencement Address, 1887, by Regent Swift.

Addresses at the Inauguration of Horace Davis as President of the University, March 23, 1888.

Formal Recognition of the Transfer of the Lick Observatory to the Board of Regents of the University, June 27, 1888.

Registers of the University, 1886–87 and 1887–88.

Circular of the College of Letters and the Colleges of Science, 1887. (Bulletin No. 6, Eleventh Edition.)

Annual Announcements of Courses of Instruction in the Colleges at Berkeley for the Academic years 1887–88 and 1888–89.

Annual Reports of the Secretary to the Board of Regents of the University for the years ending June 30, 1887, and June 30, 1888.

Agricultural Bulletins. (See below, in Report of the Professor of Agriculture and Director of the Experiment Stations, p. 75.)

Publications of the Lick Observatory, Volume I.

Annual Announcements of the Colleges of Medicine, Dentistry, and Pharmacy, for 1887 and 1888.

WANTS.

The wants of the various departments have been set forth in some detail by the Professors in charge, and may be found in their reports. I will allude to a few of a more general character which are pressing upon us.

CHEMICAL LABORATORY.

There is urgent need for the immediate construction of a chemical laboratory. The room now used is located in the basement of South Hall. It is too small for our present classes, and is, therefore, overcrowded; too low in ceiling, making it ill ventilated; and the department is very much hampered in its usefulness for these reasons. In addition, its fumes are offensive to the other occupants of the South Hall, and injurious to the contents of the building; the danger of fire resulting from its presence is, moreover, a constant menace to the very valuable collections stored under the same roof. The Board of Regents have under contemplation the erection of a separate building for the chemical laboratory at an early date.

MUSEUM BUILDING.

The Museum ought to have a separate fire-proof building, where its invaluable collections could be safe from fire. I hope some large-hearted friend of education will erect this building for us, making it his lasting monument.

WOMEN'S BUILDING.

The young women at Berkeley, over seventy in number, ought to have a hall of their own, where they could have comfortable study and reception rooms, with a gymnasium, and possibly a dining room and dormitories. Perhaps some woman, interested in the education of her sex, will come to our rescue in this matter.

DORMITORIES.

The accommodations at Berkeley for students' rooms and board are very limited, and in most cases inferior in character. The college maintains neither commons nor dormitories, indeed, the latter were forbidden by section twenty-five of the organic Act; but this clause was dropped from the section when it was reënacted, in 1872, so that the erection of dormitories is not now prohibited. A reference to the Register will show that forty-five per cent of our students live either in San Francisco or Oakland, and are obliged to spend nearly three hours a day in going and coming. This enormous waste of time and strength is taken from the hours which ought to be devoted to study, physical exercise, and recreation, and must be a serious loss to the student, interfering materially with his scholarship.

The scattering of the students, as soon as the exercises are over, prevents, in a great measure, the meeting of evening literary societies, so common in other colleges, and tends to keep down the academic spirit which, rightly guided, is of great help to any college.

AID TO STUDENTS.

As tuition is free, there is not as much pecuniary assistance required for students at Berkeley as in those colleges where a tuition fee is exacted. Still, it is hard to expect of a young man to maintain a reputable standing in his studies and to earn his livelihood in addition, when his studies alone are presumed to be as much as he ought to carry. Some such cases as these are before us all the time, and appeal deeply to our sympathy. A few chances for employment about the University are at our disposal, amounting in all to, perhaps, $2,000 a year; but a small fund that could be devoted to this purpose, or a few scholarships of say $150 or $200 a year, would be a great blessing to carry through college worthy men who, under existing circumstances, often are compelled to deny themselves a liberal education.

We also need very much some means of assistance for graduate students. It is of great benefit to the University to maintain these higher grades of study, and to keep around it a body of these advanced students. Here, also, we avail ourselves of the minor positions on the staff of instruction and in the laboratories for the support of these young men.

A few fellowships, to assist graduates of the University in the continuance of their studies, whether at Berkeley or elsewhere, would also be of great help.

THE HARVARD CLUB PRIZE.

This is a prize of not less than $200 awarded annually by the Harvard Club of San Francisco, to some graduate of the University of California; the prize to be used by the recipient in the pursuit of post-graduate study at Harvard College.

In 1887, in accordance with the recommendation of the Academic Council, the prize, amounting to $250, was awarded to Adolph Caspar Miller, A.B., 1887; and in 1888, the same amount was again awarded to Mr. Miller.

AFFILIATED PROFESSIONAL COLLEGES.

I am glad to be able to report that the Professional Colleges are all in a flourishing condition. The desire for sound learning and a high standard of instruction animates them all, and they have all materially increased their entrance requirements during the last few years, and, in some cases, lengthened the term of study required for a degree. For the particulars of their progress and condition, I beg to refer you to the reports of the Deans of the different colleges, which form part of this document.

In conclusion, I ought to state that for the carefully constructed tables included in my own report, I am indebted to the painstaking diligence of Mr. W. W. Deamer, Recorder of the Faculties at Berkeley, and Mr. Finlay Cook, clerk to the Recorder.

All which is respectfully submitted.

HORACE DAVIS,
President.

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COLLEGES AT BERKELEY.

REPORT OF THE DEAN OF THE COLLEGES OF LETTERS, AGRICULTURE, MECHANICS, MINING, CIVIL ENGINEERING, AND CHEMISTRY.

To the President of the University of California:

SIR: I have the honor to submit herewith the following general report on attendance and courses of instruction in the Colleges of Letters, Agriculture, Mechanics, Mining, Civil Engineering, and Chemistry, for the academic years 1886–87 and 1887–88.

ATTENDANCE.

The following tables exhibit in detail the number of persons enrolled during the past four years; (1) in the several classes into which the students are grouped, (2) in the eight undergraduate courses. The upper figures on the left refer to young men, the lower to young women; the numbers in lower right-hand corner of each group are the totals.

ENROLLMENT BY CLASSES.

	ENROLLED DURING THE YEAR.								WITHDREW DURING THE YEAR.					
	1884–85.		1885–86.		1886–87.		1887–88.		1885–86.		1886–87.		1887–88.	
Graduates	5		11		8		8		2		2		3	
	0	5	2	13	1	9	4	12	2	4	0	2	1	4
Seniors	18		13		29		29		1		0		2	
	7	25	4	17	5	34	3	32	0	1	0	0	0	2
Juniors	15		30		37		34		1		4		2	
	3	18	5	35	4	41	3	37	0	1	0	4	0	2
Sophomores	35		40		45		40		3		6		3	
	4	39	4	44	5	50	10	50	0	3	2	8	0	3
Freshmen	61		63		68		75		15		9		11	
	8	69	6	69	8	76	18	93	0	15	0	9	3	14
At large	16		11		14		26		4		6		5	
	1	17	0	11	1	15	2	28	0	4	0	6	0	5
Special	10		12		16		21		3		9		12	
	0	10	4	16	5	21	5	26	0	3	1	10	2	14
Limited	36		27		26		19		5		3		6	
	22	58	18	45	16	42	9	28	4	9	5	8	1	7
Totals	196		207		243		252		34		39		44	
	45	241	43	250	45	288	54	306	6	40	8	47	7	51

ENROLLMENT BY COLLEGES.

	Enrolled During the Year.								Withdrew During the Year.					
	1884–85.		1885–86.		1886–87.		1887–88.		1885–86.		1886–87.		1887–88.	
Classical Course	45		42		48		47		4		5		2	
	6	51	4	46	4	52	4	51	1	5	0	5	1	3
Literary Course	26		22		27		20		4		4		1	
	26	52	23	45	23	50	20	40	4	8	7	11	4	5
Course in Letters and Political Science	38		51		66		79		11		7		14	
	10	48	14	65	15	81	27	106	1	12	1	8	2	16
College of Agriculture	8		7		6		6		0		4		2	
	0	8	0	7	0	6	0	6	0	0	0	4	0	2
College of Mechanics	10		14		18		22		0		4		4	
	0	10	0	14	0	18	0	22	0	0	0	4	0	4
College of Mining	20		23		17		24		8		5		7	
	0	20	0	23	0	17	0	24	0	8	0	5	0	7
College of Civil Eng.	29		28		37		33		1		5		5	
	1	30	1	29	1	38	1	34	0	1	0	5	0	5
College of Chemistry	20		20		24		21		6		5		9	
	2	22	1	21	2	26	2	23	0	6	0	5	0	9
Totals	196		207		243		252		34		39		44	
	45	241	43	250	45	288	54	306	6	40	8	47	7	51

Under the heading, "Withdrew during the year," are included the following:

	1885–86.	1886–87.	1887–88.
Received honorable dismissal	3	4	3
Withdrew informally	16	2	28
Obtained leave of absence	20	37	20
Dropped from the roll	1	4	0
Totals	40	47	51

Of those who had previously obtained leaves of absence, thirteen returned in 1886–87; three of these were obliged to withdraw later in the same year, one for financial reasons, the other two for reasons not known. Of those who were given leaves of absence in 1886–87, eight returned last year, three of whom were, before its close, obliged to sever permanently their connection with the University, two because of ill health, the third on account of financial disabilities. Two students have died within the past two years—Livingston Gilson, Jr., a student at large in the College of Agriculture, who, on account of ill health, had obtained a year's leave of absence in September, 1886, and Joseph Alonzo Norris, at the time of his death, in the summer of 1887, a member of the Sophomore class in the College of Civil Engineering.

Students asking for honorable dismissal or leave of absence have, in the majority of instances, not given the reason for being obliged to discontinue their work at the University, but it is known to us that in fifteen cases the cause was ill health, in seven weakness of eyes, in thirteen financial embarrassment or business, in two the death of a relative, in two removal from this part of the State, in one desire to study medicine, in one desire to enter the College of Pharmacy, and in one an expressed intention to spend another year in preparation for college. It is probable that of the remaining forty-five the majority left the University for financial reasons.

THE COURSES OF INSTRUCTION.

The following table exhibits with some detail the entire scheme of courses, as given during the past two years, and the attendance upon each course:

RECORD OF SUBJECTS TAUGHT AND OF ATTENDANCE IN EACH CLASS PURSUING THEM.

Note.—In the columns headed "No. of Students in Attendance," etc., the upper figures on the left refer to young men, the lower to young women; the numbers on right side of column are the totals.

Instructor.	Number	No. of Course as given in University Register	Title and Description of Course.	1886–87. No. Hours a Week. 1st Term	1886–87. No. Hours a Week. 2d Term	1886–87. No. of Students in Attendance	1886–87. No. of Students Passing Final Examination	1887–88. No. Hours a Week. 1st Term	1887–88. No. Hours a Week. 2d Term	1887–88. No. of Students in Attendance	1887–88. No. of Students Passing Final Examination
			PHILOSOPHY.								
Prof. Howison	1	I	Propædeutic to Philosophy. The Logic underlying Grammar; Familiarization of the Common Categories by their use in the Analysis of Propositions and Terms. Lectures. No text-book used	1	1	15 8, 23	8 6, 14	----	----	----	----
Prof. Howison	2	I	Propædeutic to Philosophy. Deductive Formal Logic. Hill's *Jevons' Logic;* Howison's *Synopsis of Formal Logic, in Questions*	----	----	----	----	1	1	28 5, 33	17 4, 21
Prof. Howison	3	II	Introduction to Philosophy. Empirical Psychology, including Formal Logic, deductive and inductive; General History of Philosophy. Lotze's *Outlines of Psychology*, trans. by G. T. Ladd; Hill's *Jevons' Logic;* Schwegler's *History of Philosophy*, trans. by J. H. Stirling	3	3	16 2, 18	12 1, 13	3	3	13 3. 16	4 2, 6
Prof. Howison	4	III	Elementary Ethics, Historically Treated. Including a critique of perfectionism and hedonism, of necessity and freedom, and of optimism and pessimism. Sidgwick's *Outlines of the History of Ethics*	2	----	6 3, 9	6 3, 9	2	----	9 0, 9	9 0, 9
Prof. Howison	5	IV	Elements of Civil Polity. The nature of a state, and its bearing on the limits of allegiance and liberty; including a brief sketch of the history of political theories. Mulford's *The Nation;* Bluntschli's *Theory of the State*	----	2	6 3, 9	5 3, 8	----	2	10 0, 10	9 0, 9
Prof. Howison	6	V	Descartes and Spinoza. Dualism and Monism	2	----	2 1, 3	1 1, 2	----	----	----	----
Prof. Howison	7	VI	Spinoza and Leibnitz. Pantheism and Monadism, or Universalism and Individualism. Spinoza's *Ethic*, trans. by White; Leibnitz's *Monadology*, trans. by Hedge	----	2	2 1, 3	2 1, 3	----	----	----	----
Prof. Howison	8	VII	Leibnitz and Locke. Rationalism and Empiricism	2	----	4 2, 6	1 1, 2	----	----	----	----

Prof. Howison	9	VIII	HUME AND KANT. Development of Scepticism latent in both Empiricism and Rationalism. Critique of the foundations of Agnosticism. Hume's *Enquiry concerning Human Understanding;* Schwegler's *History of Philosophy*, trans. by J. H. Stirling	----	2	3 2, 5	2 1, 3	----	----	----	----
Prof. Howison	10	XVIII	PHILOSOPHY OF RELIGION, HISTORICALLY CONSIDERED. God, duty and immortality, as treated by the leaders of philosophy from Anaxagoras to Lange. Zeller's *Outlines of the History of Greek Philosophy*, trans. by Alleyne and Abbott; Schwegler's *History of Philosophy*, trans. by J. H. Stirling	----	----	----	----	2	----	11 0, 11	8 0, 8
Prof. Howison	11	XIX	PHILOSOPHY OF RELIGION: THE RATIONAL FOUNDATIONS OF THEISM. Critique of Mill's *Essay on Theism*, and Kant's *Dialectic of Pure Reason*	----	----	----	----	----	2	8 1, 9	6 0, 6
			HISTORY AND POLITICAL SCIENCE.								
Dr. Levermore (1886–87, and first term, 1887–88), Mr. Bacon (second term, 1887–88).	12	I	ENGLISH HISTORY. Special attention was directed to the history and political institutions of England in the seventeenth and eighteenth centuries. Bright's *History of England;* Lecky's *History of England in the XVIII Century*	4	4	45 7, 52	34 6, 40	4	4	31 15, 46	36 2, 38
Dr. Levermore (1886–87, and first term, 1887–88), Mr. Bacon (second term, 1887–88).	13	II	EUROPEAN HISTORY. The history of Continental Europe from the fifth century to the present time. Church's *Beginnings of the Middle Ages;* Johnson's *Normans in Europe;* Bryce's *Holy Roman Empire;* Lodge's *History of Modern Europe;* Hæusser's *Period of the Reformation;* Putzger's *Hist. Atlas;* Stieler's *Schul-Atlas*	4	4	9 6, 15	6 5 11	4	4	36 12, 48	26 4, 3
Asst. Prof. Jones	14	III	UNITED STATES HISTORY. (*a*) The social, political, and constitutional history of the Colonies; history of the Revolution, of the government under the Articles of Confederation, and of the formation of the Constitution. Hildreth; Lodge's *English Colonies;* Lecky's *England in the XVIII Century;* Crane and Moses' *Politics*	----	4	15 2, 17	10 2, 12	----	4	21 9, 30	20 8, 28
			(*b*) Principles of constitutional law; political and constitutional history from 1789 to about 1846. Cooley's *Principles of Constitutional Law;* Curtis' *Formation of the Constitution;* Young's *American Statesman;* Bancroft's *Formation of the Constitution;* Poole's *Dr. Cutler and the Ordinance of 1787;* Adams' *Maryland's Influence*	4	----	13 2, 15	13 2, 15	4	----	17 2, 19	8 2, 10
			(*c*) Political and constitutional history from about 1846 to 1876. Young's *American Statesman;* Schouler; Von Holst; Lalor's *Cyclopædia*	----	4	15 1, 16	15, 1, 16	----	4	16 2, 18	13 2, 15

TABLE OF SUBJECTS TAUGHT AND OF ATTENDANCE IN EACH CLASS PURSUING THEM—Continued.

INSTRUCTOR.	Number	No. of Course as given in University Register	TITLE AND DESCRIPTION OF COURSE.	1886–87.				1887–88.			
				No. Hours a Week.		No. of Students in Attendance.	No. of Students Passing Final Examination.	No. Hours a Week.		No. of Students in Attendance.	No. of Students Passing Final Examination.
				1st Term.	2d Term.			1st Term.	2d Term.		
Asst. Prof. Jones	15	IV	ROMAN LAW. History of the development of the public and private law of the Romans; systematic and historical exposition of Roman Law, with comparative views of the chief modern systems. Hunter's *Roman Law*	4	-----	12 0, 12	11 0, 11	4	-----	11 0, 11	11 0, 11
Asst. Prof. Jones	16	IV	JURISPRUDENCE. Holland's *Jurisprudence*	-----	1	11 0, 11	5 0, 5	-----	-----	-------	-------
Asst. Prof. Jones	17	V	CONSTITUTIONAL LAW OF THE UNITED STATES. Critical study of the leading judicial decisions on the Constitution	-----	-----	-------	-------	-----	2	5 0, 5	5 0, 5
Prof. Moses	18	VI	POLITICAL ECONOMY. A general view of the principles and laws of political economy in its present position. Mill's *Principles of Political Economy*; Walker's *Political Economy*; Jevons' *Money and the Mechanism of Exchange*; Ingram's *History of Political Economy*	-----	4	30 5, 35	27 4, 31	-----	4	29 3, 32	22 2, 24
Prof. Moses	19	VII	ADVANCED POLITICAL ECONOMY. A critical study of the history of economic thought	4	-----	11 4, 15	11 4, 15	4	-----	16 1, 17	13 1, 14
Prof. Moses	20	VIII	COMPARATIVE CONSTITUTIONAL HISTORY. A comparative view of the development and present condition of the political institutions of the western nations	4	-----	13 4, 17	13 4, 17	4	-----	16 1, 17	15 1, 16
Prof. Moses	21	IX	HISTORY OF POLITICAL THEORIES. The history of political thought, and its practical influence on institutions. Aristotle's *Politics*; Machiavelli's *Prince* and *Discourses on Livy*; Hobbes' *Leviathan*	-----	4	13 4, 17	13 4, 17	6	4	16 1, 17	14 1, 15
			PHILOLOGY.								
			The following introductory Courses for undergraduates were intended as preparatory to graduate work:								
Prof. Kellogg	22	I	LINGUISTICS. Whitney's *Language and the Study of Language*	2	-----	13 2, 15	13 2, 15	2	-----	6 3, 9	6 3, 9

Prof. Kellogg	23	II	COMPARATIVE PHILOLOGY. Lectures	-----	2	10 0, 10	9 0, 9	-----	2	4 1, 5	4 1, 5
			GREEK.								
Mr. Deamer (1886–87), Mr. Senger (1887–88)	24	I	SELECTIONS FROM GREEK AUTHORS. Boise and Freeman's *Selections from Greek Authors*, containing portions of Homer's Odyssey, Herodotus, Thucydides, Xenophon's Memorabilia, Plato's Phædo, Arrian and Lucian; Demosthenes' Third Olynthiac; sight reading in the Iliad. Boise's *Exercises in Greek Syntax*	4	4	11 2, 13	8 2, 10	4	4	16 1, 17	14 1, 15
Prof. Bunnell	25	II	PLATO, ÆSCHYLUS, EURIPIDES, SOPHOCLES. Plato's Apology and Crito, Æschylus' Prometheus, Euripides' Alcestis, Sophocles' Antigone; Greek composition; Euripides' Medea at sight	4	4	11 0, 11	10 0, 10	4	4	6 2, 8	6 2, 8
Prof. Bunnell	26	III	SOPHOCLES, PLATO, LYSIAS, DEMOSTHENES. Sophocles' Oedipus Tyrannus, Plato's Gorgias, Lysias' Select Orations; three Phillippics of Demosthenes at sight. Lectures on Greek archæology	2	3	5 0, 5	4 0, 4	2	3	8 0, 8	7 0, 7
Prof. Bunnell	27	IV	DEMOSTHENES, ÆSCHINES, ARISTOPHANES. Demosthenes' Oration on the Crown, Æschines' Oration against Ctesiphon, Demosthenes' Oration against Leptines, Lucian, Aristophanes' Frogs, Clouds or Birds; reading at sight	3	2	1 0, 1	1 0, 1	3	3	4 0, 4	4 0, 4
Prof. Bunnell	28	V	GREEK LITERATURE. Lectures	-----	1	2 2, 4	1 2, 3	-----	-----	-----	-----
			LATIN.								
Mr. Deamer	29	I	LIVY, CICERO, HORACE. Two books of Livy, Cicero's De Senectute, the Odes of Horace; Latin composition. Abbott's *Latin Prose through English Idiom*	4	4	33 9, 42	23 8, 31	4	4	30 4, 34	24 3, 27
Mr. Deamer	30	II	HORACE, CICERO, PLAUTUS, TERENCE. Satires and Epistles of Horace, Cicero's De Officiis, two plays of Plautus, one play of Terence	3	3	17 3, 20	14 2, 16	3	3	17 10, 27	24 1, 25
Prof. Kellogg	31	III	CICERO, QUINTILIAN, JUVENAL, TACITUS. Cicero's Brutus, Quintilian's Institutes, Annals of Tacitus, Satires of Juvenal	5	3	11 4, 15	11 3, 14	5	3	13 2, 15	12 2, 14
Prof. Kellogg	32	IV	CICERO, LUCRETIUS, VERGIL, ELEGIAC POETS. Cicero's De Natura Deorum and Tusculan Disputations, Lucretius' De Rerum Natura, selections from Vergil, Catullus, etc.	2	5	7 4, 11	7 3, 10	2	5	12 3, 15	12 3, 15
Prof. Kellogg	33	V	ROMAN ARCHÆOLOGY. Course based on Wilkins' *Roman Antiquities*	-----	1	12 0, 12	11 0, 11	-----	1	7 2, 9	7 2, 9
Prof. Kellogg	34	VI	ROMAN LITERATURE. Course based on Cruttwell's *History of Roman Literature*	2	-----	3 2, 5	3 2, 5	2	-----	4 0, 4	4 0, 4

Record of Subjects Taught anl of Attendance in each Class Pursuing them—Continued.

Instructor.	Number	No. of Course as given in University Register	Title and Description of Course.	1886–87.				1887–88.			
				No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination	No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination
				1st Term	2d Term			1st Term	2d Term		
			ENGLISH.								
Asst. Prof. Bradley and Mr. Stoddard.	35	I	English Prose Style. Study of English prose composition on the basis of Minto's *Manual of English Prose Literature* and Lewes' *Principles of Success in Literature*	4	4	67 12, 79	51 9, 60	4	4	79 18, 97	60 13, 73
Asst. Prof. Bradley (1886–87), Mr. Stoddard (1887–88).	36	II	Preparation of Summaries. Exercises in abstracting and tabulating. *The Précis Book*	1	-----	23 0, 23	18 0, 18	1	-----	33 1, 34	30 1, 31
Mr. Stoddard (1886–87), Asst. Professor Bradley (1887–88).	37	III	History of English Literature. A rapid survey of the whole field, followed by the study of representative authors in chronological order. Brooke's *Primer*; Morley's *English Literature*	3	-----	36 8, 44	33 6, 39	3	-----	34 9, 43	27 9, 36
Mr. Stoddard (1886–87), Asst. Professor Bradley (1887–88).	38	IV	English Classics. A course in *belles lettres*, based upon selections from eminent poets and prose writers. Palgrave's *Golden Treasury of Songs and Lyrics*; Cook's *Touchstones of Poetry*	-----	3	33 6, 39	29 4, 33	-----	3	28 9, 37	25 9, 34
Prof. Cook	39	V	Shakespeare. Critical study of one or more plays. *Macbeth*; *Hamlet*; Globe Shakespeare	3	-----	6 3, 9	6 2, 8	3	-----	11 3, 14	11 3, 14
Prof. Cook	40	VII	Burke. A critical and comparative study of Burke's life, opinions and style	-----	-----	-------	-------	-----	3	11 0, 11	10 0, 10
Prof. Cook (1886–87), Mr. Stoddard (1887–88).	41	VIII	Old English. Reading of simple prose; elements of Old English grammar as an introduction to the historical study of English. Sweet's *Anglo-Saxon Reader*; Cook's *Sievers' Old English Grammar*; Braune's *Gothic Grammar*	-----	3	6 3, 9	5 3, 8	-----	3	8 3, 11	5 3, 8
Pr . Cook	42	IX	Chaucer and Middle English. Critical study of selected works of Chaucer; survey of Middle English literature; studies in phonology and syntax; dialectical variations; development of the language from the Old English period	3	-----	1 0, 1	1 0, 1	3	-----	2 0, 2	2 0, 2
Prof. Cook	43	X	Advanced Old English; Beowulf. Critical study of Beowulf; survey of Old English literature; lectures on Old English grammar. Harrison & Sharp's *Beowulf*; Wülcker's *Geschichte der Angelsächsischen Litteratur*; Sweet's *Anglo-Saxon Reader*; Cook's *Sievers' Old English Grammar*	-----	3	2 3. 5	2 3, 5	-----	-----	-------	-------

Prof. Cook	44	XI	Milton. A critical study of Milton's character, opinions and works. The Globe Milton; *Milton Anthology;* Brooke's *Milton*						3	8 2, 10	7 2, 9
Prof. Cook	45	XII	Literary Masterpieces. A course of reading to be pursued throughout the year, under the advice and direction of the professor in charge	3	3	13 7, 20	13 7, 20	3	3	16 4, 20	15 4, 19
Mr. Stoddard	46	XIII	Themes. *Freshman year:* Four themes each term are required in all courses			74 14, 88				95 18, 113	
Asst. Prof. Bradley			*Sophomore Year:* Four themes each term are required in the Classical and Literary courses, and the course in Letters and Political Science; three themes each term are required in all the Scientific courses			47 5, 52				42 11, 53	
Prof. Cook			*Junior Year:* Two themes each term are required in all courses			36 3, 39				38 5, 43	
Prof. Cook			*Senior Year:* Two themes each term are required in the Classical and Literary courses, and the course in Letters and Political Science			17 7, 24				25 3, 28	
			GERMAN.								
Prof. Putzker and Mr. Senger.	47	I	Introductory Course. *First Year:* Meissner's *German Grammar*, with references to other German grammars; Boisen's *Preparatory Book of German Prose*	4	4	49 6, 55	40 6, 46	4	4	50 13, 63	34 13, 47
Prof. Putzker	48		*Second Year:* Schiller. Maria Stuart, Wilhelm Tell, Die Jungfrau von Orleans, and perhaps other writings. Lectures on the topics under consideration; one exercise in grammar and syntax a week. Written exercises and conversational practice throughout the Course	4	4	33 6, 39	29 4, 33	4	4	37 9, 46	32 9, 41
Mr. Senger	49	II	Middle High German. German literature of the middle ages. The Nibelungenlied; the Minnesingers; translation from Middle High German into Modern German		2	2 1, 3	1 1, 2				
Mr. Senger	50	III	Goethe. In the class room, selected masterpieces of Goethe, *e. g.*, Hermann und Dorothea, Gœtz von Berlichingen, Iphigenie auf Tauris, Egmont; Gœdcke's *Goethe's Leben;* lectures on the topics under consideration; written exercises. Outside of the class room the study of Schiller continued from the second year of Course I	3	3	14 7, 21	12 6, 18	3	3	9 3, 12	6 3, 9
Prof. Putzker	51	IV	Lessing. In the class room, selected masterpieces of Lessing, *e. g.*, Emilia Galotti, Minna von Barnhelm, Nathan der Weise; Gœring's *Lessing's Leben;* lectures on the topics under consideration; written exercises. Outside of the class room, the study of Goethe's works continued from Course III.; special work assigned in some cases	2	2	8 7, 15	8 7, 15	2	2	13 6, 19	12 5, 17

RECORD OF SUBJECTS TAUGHT AND OF ATTENDANCE IN EACH CLASS PURSUING THEM—Continued.

INSTRUCTOR.	Number	No. of Course as given in University Register	TITLE AND DESCRIPTION OF COURSE.	1886–87.				1887–88.			
				No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination	No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination
				1st Term	2d Term			1st Term	2d Term		
			FRENCH.								
		I	INTRODUCTORY COURSE. In order to meet the wants of students who desire to obtain a reading knowledge only, the introductory course is devoted mainly to translating French into English. An effort is made, however, to give students some facility in understanding French when spoken, and some power of expressing themselves in French. Accordingly, occasional lectures in French, on the history of the language, are given as early as practicable; an endeavor is made to use the language in conducting the recitations; translation of English into French begun.								
Prof. Owen (1886–87)	52		*First Year:* Otto's *French Grammar;* Le Cid; Le Misanthrope. A part of the Roman d'un Jeune Homme Pauvre read in the class, the remainder was read outside of the class, for examination	4	4	16 1, 17	13 0, 13	----	----	----	----
Prof. Owen (1886–87)	53		*Second Year:* Otto's *French Grammar;* Athalie, La Petite Fadette read outside of the class, for examination. Further like work was assigned as occasion required	3	3	20 3, 23	13 2, 15	----	----	----	----
Mr. Paget (1887–88)	52		*First Year:* Keetels's *Elementary French Grammar;* Athalie. A part of Le Roi des Montagnes read in the class; the remainder was read outside of the class, for examination	----	----	----	----	4	4	26 11, 37	25 7, 32
Mr. Paget (1887–88)	53		*Second Year:* Keetels's *Elementary French Grammar;* Horace; Discours sur le style (Buffon); Hernani; Le Misanthrope. L'Abbé Constantin and L'Ami Fritz read outside of the class, for examination. Further like work was assigned as occasion required	----	----	----	----	3	3	10 1, 11	8 1, 9

		II	ADVANCED COURSE. The assignment of independent reading for the Advanced Course is made as occasion requires. In both Courses the books assigned are provided with ample notes; and an opportunity given before examinations for students to ask questions upon difficulties which may have been overlooked in the notes.								
Mr. Paget (1887–88)	54		*First Year: Grammaire Française (cours supérieur)* by A. Chassang. The lectures on the French language continued, and a new series of lectures in French, on French literature	-----	-----	-----	-----	3	3	9 1, 10	7 1, 8
			SPANISH.								
Prof. Owen (1886–87)	55	I	INTRODUCTORY COURSE. Sauer's *Spanish Conversation Grammar.* Reading matter assigned as occasion required	3	3	3 0, 3	3 0, 3	-----	-----	-----	-----
Mr. Paget (1887–88)			Monsanto and Languellier's *Practical Course with the Spanish Language.* Reading matter assigned as occasion required	-----	-----	-----	-----	3	3	2 0, 2	-----
			MATHEMATICS.								
		I	SOLID AND SPHERICAL GEOMETRY, ALGEBRA, TRIGONOMETRY, ANALYTIC GEOMETRY. The distribution of the work was as follows:								
Asst. Prof. Edwards	56		(1). *Solid and Spherical Geometry.* Freshman year. Venable's *Geometry*	4	-----	76 10, 86	53 4, 57	4	-----	79 14, 93	57 8, 65
Asst. Prof. Edwards	57		(2). *Algebra.* Freshman year. Wells' *University Algebra;* Clarke's *Algebra*	-----	4	70 11, 81	49 9, 58	-----	4	65 20, 85	41 12, 53
Asst. Profs. Edwards and Clarke.	58		(3). *Trigonometry and Analytic Geometry.* Sophomore year. Wells' *Trigonometry;* C. Smith's *Conic Sections*	4	-----	36 8, 44	19 3, 22	4	-----	51 7, 58	19 4, 23
		II	ALGEBRA, TRIGONOMETRY, GEOMETRY, DIFFERENTIAL CALCULUS. The distribution of the work was as follows:								
Asst. Prof. Clarke	59		(1). *Algebra.* Theory and discussion of algebraic expressions, and the solution of algebraic equations. Solution of simultaneous equations. Elements of the Theory of Determinants. Discussion of series. First term of Freshman year. Todhunter's *Theory of Equations*	3	-----	27 1, 28	14 1, 15	3	-----	36 1, 37	26 1, 27
Asst. Prof. Clarke	60		(2). *Trigonometry.* The development of the general formulæ of plane and spherical trigonometry, solution of plane and spherical triangles, the use of logarithmic tables. Second term of Freshman year. Clarke's *Trigonometry*	-----	2	23 1, 24	10 0, 10	-----	2	34 1, 35	12 1, 13
Prof. Stringham and Asst. Prof. Clarke.	61		(3). *Synthetic Geometry.* Résumé of the fundamental propositions of the Euclidian geometry of space, and a course in modern projective geometry. Venable's *Geometry* and Casey's *Sequel to Euclid*	3	-----	26 1, 27	13 1, 14	3	-----	38 1, 39	19 1, 20

Record of Subjects Taught and of Attendance in each Class Pursuing them—Continued.

Instructor.	Number	No. of Course as given in University Register	Title and Description of Course.	1886–87.				1887–88.			
				No. Hours a Week. 1st Term	No. Hours a Week. 2d Term	No. of Students in Attendance	No. of Students Passing Final Examination	No. Hours a Week. 1st Term	No. Hours a Week. 2d Term	No. of Students in Attendance	No. of Students Passing Final Examination
Prof. Stringham	62		(4). *Analytic Geometry and the Differential Calculus.* (*a*) Equations of the straight line, the circle and the conic sections, including the discussion of the general equation of the second degree. (*b*) First principles of the differential calculus. C. Smith's *Conic Sections*	-----	3	30 2, 32	13 2, 15	-----	2	35 4, 39	19 3, 22
			(5). *Mathematical Exercises.* Trigonometry and conic sections. The work requires no preparatory study.								
Asst. Prof. Clarke	60		(*a*) In Trigonometry (once a week)	-----	-----	-----	-----	-----	1	34 1, 35	12 1, 13
Prof. Stringham	62		(*b*) In Conic Sections (once a week)	-----	-----	-----	-----	-----	2	35 4, 39	19 3, 22
		III	Differential and Integral Calculus; Analytic Geometry of Three Dimensions.								
Asst. Prof. Clarke (1886–87), Prof. Stringham (1887–88).	63		(*a*) The Differential and Integral Calculus. Greenhill's *Calculus*	-----	3	15 0, 15	11 0, 11	3	-----	18 0, 18	11 0, 11
Asst. Prof. Clarke	64		(*b*) The Analytic Geometry of Space. C. Smith's *Solid Geometry*	3	-----	17 0, 17	9 0, 9	-----	3	14 0, 14	8 0, 8
Prof. Stringham	63	IV	Mathematical Exercises. (*a*) In the Differential and Integral Calculus (twice a week)	-----	3	15 0, 15	11 0, 11	3	-----	16 0, 16	9 0, 9
Asst. Prof. Clarke	64	-----	(*b*) In the Analytic Geometry of Space (twice a week)	3	-----	17 0, 17	9 0, 9	-----	3	14 0, 14	8 0, 8
Asst. Prof. Edwards	65	V	Analytic Geometry. The straight line, the circle and the conic sections, treated by the analytical method. Supplementary to Course I, (2). Wood's *Coördinate Geometry*	-----	2	2 0, 2	2 0, 2	-----	2	1 1, 2	1 1, 2
Asst. Prof. Clarke	66	VII	Modern Methods in Geometry. After Reye, Cremona, and Poncelet	-----	-----	-----	-----	-----	2	2 1, 3	-----

Asst. Prof. Clarke	67	VIII	QUATERNIONS. An elementary presentation of the principles of the subject, with illustrations of its applications to geometry and mechanics	2	2	1 0, 1	1 0, 1	----	----	----	----
Prof. Stringham	68	IX	DIFFERENTIAL EQUATIONS. Theory and methods of solution of total differential equations. Forsyth's *Differential Equations.* Osborne's *Examples of Differential Equations*	2	2	4 0, 4	4 0, 4	2	2	3 0, 3	3 0, 3
Asst. Prof. Edwards	69	X	DIFFERENTIAL AND INTEGRAL CALCULUS. An elementary Course, designed for students in Non-Scientific courses who may wish to continue their mathematical studies after the Sophomore year, and also for students in the Scientific courses who are not required to pursue the full course in mathematics, but who desire some acquaintance with the calculus and its most important applications. Todhunter and Bowser	2	2	4 0, 4	2 0, 2	2	2	2 0, 2	1 0, 1
Asst. Prof. Clarke	70	XI	ADVANCED ANALYTIC GEOMETRY, AND CURVE TRACING. Introduction to higher plane curves and to the analytic geometry of three dimensions; tracing of plane curves	----	----	----	----	2	2	1 0, 1	1 0, 1
Asst. Prof. Slate	71	XII	ANALYTIC MECHANICS. (*a*) The mathematical treatment of the important principles of dynamics and statics, fully illustrated by problems and applications. Williamson and Tarleton's *Dynamics*	4	4	8 0, 8	4 0, 4	4	4	9 0, 9	9 0, 9
Asst. Prof. Slate			(*b*) Course supplementary to the preceding. Williamson and Tarleton's *Dynamics*	2	2	5 0, 5	2 0, 2	2	2	3 0, 3	3 0, 3
Prof. Hesse	72	XIII	HYDRODYNAMICS. Investigations in the action of forces upon liquid bodies, either in producing equilibrium (hydrostatics), or motion (hydrodynamics), such as pressure, stability, flow through orifices, pipes, etc., under the influence of gravity, inertia, outer and inner friction	4	----	13 0, 13	13 0, 13	4	----	5 0, 5	4 0, 4

Record of Subjects Taught and of Attendance in each Class Pursuing them—Continued.

Instructor.	Number	No. of Course as given in University Register	Title and Description of Course.	1886–87.				1887–88.			
				No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination	No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination
				1st Term	2d Term			1st Term	2d Term		
Prof. John LeConte	73	I	PHYSICS. General Physics. Lectures on the following topics, illustrated by experiments: *Heat.* Thermometry; laws of expansion of solids, liquids and gases; of conduction and convection; of liquefaction and solidification; of ebullition; of elastic force of vapors; theory of the steam engine; laws of vaporization and condensation; spontaneous evaporation; hygrometry; laws of specific heat; sources of heat; mechanical equivalent of heat; heat of combustion; dynamical theory of heat. *Mechanics.* Properties of matter; measure of force; motion, and laws of motion; composition and resolution of forces; centrifugal force; laws of gravity and falling bodies; centre of gravity; elementary machines; laws of friction; motion on inclined planes; theory of the pendulum; impact of bodies; projectiles	4	----	54 6, 60	50 6, 56	4	----	43 3, 46	36 3, 39
Prof. John LeConte			*Mechanics of Liquids:* Transmission of pressure; buoyancy; specific gravity; motion of liquids; spouting liquids; motion of water in pipes, canals and rivers; theory of water motors; hydraulic ram. *Mechanics of Gases:* Laws of compressibility and elasticity; atmospheric pressure; theory of pumps; siphons. *Mechanics of Capillarity.* *Statical Electricity:* Electrical action; electrical forces; Leyden jar; mechanical and chemical effects; atmospheric electricity	----	4	31 1, 32	31 1, 32	----	4	19 0, 19	18 0, 18

Prof. John LeConte	74	II	Advanced Course in General Physics. Lectures on the following topics: *Magnetism:* Magnetic forces; terrestrial magnetism, diamagnetism. *Electro-Dynamics:* Power of electro-magnets; electro-dynamic induction; economy of electro-motors. *Acoustics:* Propagation of elastic waves; reflection and refraction of sound; physical theory of music. *Optics:* Velocity of light; photometry; laws of reflection, refraction and dispersion; spectroscope, polarization, etc.	2	2	6 0, 6	5 0, 5	2	-----	8 0, 8	6 0, 6
Asst. Prof. Slate	75	VI	Physical Laboratory. Exercises connected with the subject of chemical philosophy, as pursued by students of agriculture and chemistry, such as: Vapor-density determinations by the methods of Meyer, Dumas, Hofmann; determinations of boiling point, specific heat, heat developed in chemical reactions, specific gravity; galvanic measurements connected with electrolysis	-----	3	4 0, 4	4 0, 4	-----	3	6 0, 6	6 0, 6
Asst. Prof. Slate	76	VII	Physical Laboratory: Problems. Selected physical problems, involving mathematical and experimental work, such as: Experimental determination of the moment of inertia, and of the focal length and the curvature of lenses; measurements of galvanic resistance, and of electromotive force and intensity; determination of the modulus of elasticity, and of the coefficient of expansion by heat	-----	3	7 0, 7	7 0, 7	-----	3	7 0, 7	7 0, 7
Asst. Prof. Slate	77	VIII	Physical Laboratory: Problems. A continuation of Course VII, consisting of more advanced problems, involving accurate measurement and more extended knowledge. The scope of this work was varied and enlarged according to the capacity of the student and the time at his disposal	6	-----	9 0, 9	9 0, 9	6	-----	6 0, 6	5 0, 5
Prof. Jackson	78	IX	Polarized Light. With special reference to its applications in the investigation of crystal-sections. The Course closed with a consideration of the theory of the microscope, and its use in petrographical investigations. The lectures were illustrated by means of an electric-lantern polarization-microscope, and were followed by practice with the table-microscope	-----	-----	-----	-----	-----	2	3 0, 3	1 0, 1

Record of Subjects Taught and of Attendance in each Class Pursuing them—Continued.

Instructor.	Number	No. of Course as given in University Register	Title and Description of Course.	1886–87.				1887–88.			
				No. Hours a Week. 1st Term	No. Hours a Week. 2d Term	No. of Students in Attendance	No. of Students Passing Final Examination	No. Hours a Week. 1st Term	No. Hours a Week. 2d Term	No. of Students in Attendance	No. of Students Passing Final Examination
			ASTRONOMY.								
Prof. Soulé	79	I	General Astronomy. General facts and principles underlying the science of astronomy, physical and spherical, with solutions of many problems, particularly those relating to the determination of latitude, longitude, time, etc. Newcomb and Holden's *Astronomy*	-----	3	11 3, 14	11 3, 14	3	-----	7 2, 9	5 2, 7
Prof. Soulé	80	II	Practical Astronomy. A continuation and completion of the preceding Course. Doolittle's *Astronomy*. Practical work in the observatory	3	3	9 0, 9	8 0, 8	-----	3	4 0, 4	3 0, 3
			CHEMISTRY.								
Prof. Rising and Mr. O'Neill.	81	I	Elementary Chemistry. Recitations and lectures, fully illustrated by experiments. Eliot and Storer's *Elementary Manual*, and Roscoe's *Elementary Chemistry* (Inorganic part)	4	4	28 2, 30	23 1, 24	4	4	41 8, 49	39 3, 42
Prof. Rising	82	II	Experimental Lectures on Inorganic Chemistry. Roscoe and Schorlemmer's *Manual of Chemistry* read in connection with the lectures	3	3	25 2, 27	21 1, 22	3	3	27 0, 27	25 0, 25
Prof. Rising	83	III	Chemical Philosophy. *First Term:* Recitations in Cooke's text-book on the subject, supplemented by notes and explanations. *Second Term:* Short courses of lectures on thermo-chemistry, electrolysis and spectrum analysis	2	2	1 0, 1	1 0, 1	2	2	3 1, 4	3 1, 4
Prof. Rising	84	IV	Lectures on Organic Chemistry. Richter's *Organische Chemie* used as a work of reference	2	2	6 0, 6	6 0, 6	2	2	4 0, 4	2 0, 2
Mr. Harding (1886–1887). Mr. O'Neill (1887–88).	85	V	Laboratory: Qualitative Analysis. General principles of qualitative analysis, characteristic reactions and tests for bases and acids; analysis of simple and complex salts and mixtures; examination of substances in common use, or of domestic importance, for impurities or adulterations. Special attention will also be given to the general relations of the elements, and to synthetic preparations	12	8	25 2, 27	20 1, 21	12	8	30 1, 31	23 1, 24

Prof. Rising	86	VI	LABORATORY: QUANTITATIVE ANALYSIS. Gravimetric and volumetric analysis of ores, minerals, etc.; practice in the preparation of organic and inorganic compounds; organic analysis; special investigations; methods of analysis	15	15	11 0, 11	10 0, 10	15	15	8 1, 9	8 1, 9
Mr. O'Neill	87	VII	PHYSIOLOGICAL CHEMISTRY. A course of lectures, embracing a general consideration of organisms; relation to external conditions, atmospheric pressure, etc.; inorganic and organic constituents of organisms; chemistry of animal tissues and fluids; physiological functions and processes, digestion, nutrition, excretion, respiration, etc. Laboratory practice in the preparation of physiological products; tests for blood and bile constituents; urine analysis; milk analysis. Works of reference: Gamgee's *Chemistry of Animal Functions*, Hoppe-Seyler's *Physiologische Chemie*	-----	-----	-----	-----	-----	3	3 0, 3	1 0, 1
Mr. Harding (1886–1887), Mr. O'Neill (1887–88).	88	VIII	BLOWPIPE ANALYSIS: QUALITATIVE. Cornwall's or Landauer's *Blowpipe Analysis.* Laboratory practice	-----	4	22 1, 23	18 1, 19	-----	4	27 1, 28	22 1, 23
Prof. Rising	89	IX	BLOWPIPE ANALYSIS: QUANTITATIVE	-----	-----	-----	-----	-----	-----	-----	-----
			BOTANY.								
Asst. Prof. Greene	90	I	VEGETAL STRUCTURE AND MORPHOLOGY. Lectures, illustrated as fully as possible by living specimens, and recitations from Gray's *Botanical Text-Book*, Vol. I., and Bastin's *Elements of Botany*	3	-----	15 5, 20	14 3, 17	3	-----	7 2, 9	7 2, 9
Asst. Prof. Greene	91	II	SYSTEMATIC AND ECONOMIC BOTANY. Practical exercises in the determination of genera and species of the California flora; lectures on plants of commercial value, and on those useful or injurious to agriculture in California. Botany of State Geological Survey; Gray's *Synoptical Flora of North America;* Brewer and Watson's *Botany of California*	-----	3	7 0, 7	7 0, 7	-----	3	12 0, 12	9 0, 9
			ZOOLOGY.								
Prof. Jos. LeConte	92	I	COMPARATIVE ZOOLOGY. Lectures. The Course is essentially one of comparative physiology. *First Term:* Organs and functions of animal life, *i. e.*, nervous systems, sense organs, muscular and skeleton systems. *Second Term:* Organs and functions of vegetative life, *i. e.*, digestive, circulatory, respiratory and excretory systems	2	2	33 4, 37	30 3, 33	2	2	35 4, 39	34 4, 38
			GEOLOGY.								
Prof. Jos. LeConte	93	I	GEOLOGY. *First Term:* Dynamical and structural geology. *Second Term:* Historical geology	3	3	39 5, 44	37 5, 42	3	3	28 4, 32	28 4, 32

RECORD OF SUBJECTS TAUGHT AND OF ATTENDANCE IN EACH CLASS PURSUING THEM—Continued.

INSTRUCTOR.	Number	No. of Course as given in University Register	TITLE AND DESCRIPTION OF COURSE.	1886–87.				1887–88.			
				No. Hours a Week.		No. of Students in Attendance.	No. of Students Passing Final Examination.	No. Hours a Week.		No. of Students in Attendance.	No. of Students Passing Final Examination.
				1st Term.	2d Term.			1st Term.	2d Term.		
Prof. Jackson	94	II	PETROGRAPHY. General and microscopic petrography, embracing (1) the different methods of rock investigation, macroscopic, microscopic, physical and chemical; (2) rock-texture and rock-structure; (3) the different forms in which rock-masses occur; (4) classification and nomenclature; (5) descriptive petrography; (6) petrogenesis, or the origin of rocks; (7) decomposition, and other changes which rocks undergo. Sufficient laboratory practice with the microscope to enable the student to determine by its means the chief rock constituents	2	2	5 0, 5	3 0, 3	-----	-----	-----	-----
			MINERALOGY.								
Prof. Jackson	95	I	CRYSTALLOGRAPHY, MINERALOGICAL TERMINOLOGY AND DESCRIPTIVE MINERALOGY. The *crystallography* is treated with the view of enabling the student to determine natural crystals at sight, or at most with the use of the contact-goniometer. No time is spent upon mathematical crystallography; all of the work is concentrated upon descriptive crystallography. The Course is copiously illustrated by models of crystals. The *mineralogical terminology* deals with all of the physical properties of minerals that are used in determinative work, such as lustre, color, streak, optical reactions in polarized light, cleavage, fracture, hardness, etc., the student carefully examining typical specimens illustrating each property. The *descriptive mineralogy* treats in detail of the crystallographic, physical, chemical and geological properties of all geologically or economically important minerals, the student having the opportunity, immediately after each lecture, to make a careful examination of specimens illustrating every form in which each mineral occurs	2	2	13 0, 13	12 0, 12	2	2	11 1, 12	*

Prof. Jackson	96	II	Physical Determination of Minerals. Determination of unlabeled minerals by means of their physical properties only, the apparatus consisting of penknife, pocket lens, streak-plate and magnet. The object is to give the students sufficient familiarity with the most commonly occurring minerals of geological and economic importance to enable him to recognize or determine them in the field without delay	4	4	14 0, 14	11 0, 11	4	4	3 0, 3	2 0, 2

MECHANICAL ENGINEERING.

Prof. Hesse	97	I	Hydraulics: Hydraulic Motors, Pumps, Water Engines. And, in general, such machines and apparatus as operate through the agency of fluids, either in modifying motion or transmitting power	-----	4	11 0, 11	2 0, 2	-----	2	4 0, 4	3 0, 3
Prof. Hesse	98	II	Kinematics. *Theoretical:* Treatment of motion without reference to the cause which produces it, comprehending the study of pure mechanism, or the mutual dependence of the movements in the parts of a machine. *Applied:* Application of the preceding to the various kinematic problems connected with machine construction, such as link-motion, transmission by rolling and sliding contact, teeth of wheels, cams, etc.	6	6	2 0, 2	2 0, 2	6	6	3 0, 3	3 0, 3
Prof. Hesse	99	III	Thermodynamics. Mechanical theory of heat, and its application to the theory and construction of motors; of steam, gas, and hot-air engines; of ice-machines; and of air-compressors for transmission of power	2	2	2 0, 2	2 0, 2	3	3	6 0, 6	4 0, 4
Prof. Hesse	100	IV	General Machine Construction	-----	4	2 0, 2	2 0, 2	3	3	4 0, 4	3 0, 3
Prof. Hesse	101	V	Laboratory: Construction and Experimenting	6	6	2 0, 2	2 0, 2	-----	-----	--------	--------

CIVIL ENGINEERING.

Mr. Raymond	102	I	Surveying. Johnson's *Theory and Practice of Surveying*, supplemented by lectures on mine and railroad surveying, and on the theory and use of the plane-table. The instruction includes the theory and use of all modern instruments employed by surveyors in field and office work, together with field methods of making land, topographical, hydrographical, mine, railroad, canal, and city surveys, and the mapping of the same; surveys for the calculation of earthwork; the theory and use of diagrams for computing earthwork and masonry	4	4	8 0, 8	5 0, 5	4	4	15 0, 15	6 0, 6

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* Examination held in connection with that for Course II.

RECORD OF SUBJECTS TAUGHT AND OF ATTENDANCE IN EACH CLASS PURSUING THEM—Continued.

INSTRUCTOR.	Number	No. of Course as given in University Register	TITLE AND DESCRIPTION OF COURSE.	1886–87.				1887–88.			
				No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination	No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination
				1st Term	2d Term			1st Term	2d Term		
Mr. Raymond	103	II	FIELD PRACTICE AND MAPPING. Adjustment of instruments. Practice in plane and topographical surveying. Preliminary and location surveys for a line of railroad, together with the staking out of the work, the making of estimates, etc. Finished maps of all surveys are required	9	9	8 0, 8	6 0, 6	9	9	14 0, 14	10 0, 10
Prof. Soulé	104	III	STRENGTH OF MATERIALS. Character and properties of building materials, such as iron, steel, other metals, timber, natural and artificial stones; practice in the selection of good specimens and the detection of poor ones. Discussions of the elastic and ultimate resistance of these materials; deduction of formulæ for safe and for rupturing loads of beams, etc.; designs of beams of uniform strength; discussion, by both analytical and graphical methods, of torsive stresses, plane of maximum shear, and internal strains. Lectures and numerous problems	4	-----	13 0, 13	12 0, 12	4	-----	6 0, 6	4 0, 4
Prof. Soulé (1886–87), Mr. Raymond (1887–88).	105	IV	ENGINEERING STRUCTURES. Theory of joints, and of framing in wood and iron; boiler-plate joints. Theory and construction of solid and open-built girders, of roof trusses, bridge trusses, and railway bridges generally. Theory of suspension bridges, and of foundations on land and under water. Lectures and problems. De Volsen Wood's *Bridges and Roofs;* Du Bois' *Graphical Statics*	-----	4	7 0, 7	7 0, 7	-----	4	2 0, 2	2 0, 2
Prof. Soulé (1886–87), Mr. Raymond (1887–88).	106	V	SANITARY ENGINEERING. Recitations and lectures on the practical construction of works for water-supply and sewerage of cities, and for drainage of agricultural lands	2	2	7 0, 7	7 0, 7	2	2	7 0, 7	5 0, 5

Prof. Soulé	107	VI	ENGINEERING SPECIFICATIONS AND CONTRACTS. Including the law of contracts as affecting the civil engineer, his obligations, guaranties, etc.; also, the forms of specifications best suited to contracts for roofs; for framed works; for trussed, arched or suspension bridges; for foundations of structures on land or under water; and for structures of masonry	-----	-----	--------	--------	-----	2	$\overset{1}{0,}$ 1	$\overset{1}{0,}$ 1
			MINING, METALLURGY AND ASSAYING.								
Prof. Christy	108	I	MINING. Lectures. Relation of mining to other arts. Nature and occurrence of ores. Mining laws of the United States and Mexico. Location of claims. Prospecting: artesian and diamond-drill boring. Excavation; explosives and blasting. Tunneling: Systems of excavation and timbering. Shaft sinking: Systems of excavation and timbering; special methods for wet ground, such as tubbing, walling and boring. Winning and exploration of deposits. Exploitation: (1) Deep mining, methods of excavating and supporting used for working veins, beds and masses; (2) Open-cut work, quarries, peat and lake deposits, placers and hydraulic mining. Systems of tramming, hoisting, draining, pumping, lighting and ventilating. General organization and administration	3	3	$\overset{5}{0,}$ 5	$\overset{5}{0,}$ 5	3	3	$\overset{5}{0,}$ 5	$\overset{1}{0,}$ 1
Prof. Christy	109	II	METALLURGY. Lectures. *General Part:* Relation of metallurgy to mining and other arts. Classification of ores, and methods of their reduction. Ore crushing: rock breakers, rolls, stamps, grinding and pulverizing machines. Sampling of ores and products. Fuels, and their relative value as heat-producers. Furnace construction and classification. Fluxes and refractory materials. Metallurgical products. *Special Part:* In view of the local importance of the metallurgy of gold, silver, lead and quicksilver, the entire second term is devoted to a detailed study of methods in successful use for the reduction of the ores of these metals. In order to give the other metals the prominence which their importance demands, their treatment is reserved for the graduate Courses	3	3	$\overset{8}{0,}$ 8	$\overset{7}{0,}$ 7	3	3	$\overset{7}{0,}$ 7	$\overset{0}{0,}$ 0

RECORD OF SUBJECTS TAUGHT AND OF ATTENDANCE IN EACH CLASS PURSUING THEM—Continued.

INSTRUCTOR.	Number	No. of Course as given in University Register	TITLE AND DESCRIPTION OF COURSE.	1886–87.				1887–88.			
				No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination	No. Hours a Week.		No. of Students in Attendance	No. of Students Passing Final Examination
				1st Term	2d Term			1st Term	2d Term		
Prof. Christy	110	III	ASSAYING. Lectures and laboratory practice. Cupellation of gold and silver. Scorification assays of gold and silver ores. Crucible method for these ores. Parting gold and silver. Oxidizing and chloridizing, roasting and leaching, of gold and silver ores. Humid assay of silver bullion. Fire assays of ores of lead, antimony, tin, nickel, cobalt, copper, iron and fuels. Volumetric and electrolytic methods with copper, nickel, cobalt	6	6	9 0, 9	9 0, 9	6	6	7 0, 7	2 0, 2
Prof. Christy	111	IV	METALLURGICAL LABORATORY. Experiments, on a working scale, in the crushing, sampling, concentration, roasting, leaching and amalgamation of gold and silver ores	-----	6	7 0, 7	5 0, 5	-----	6	2 0, 2	2 0, 2
			AGRICULTURE AND ENTOMOLOGY.								
Prof. Hilgard	112	I	AGRICULTURAL CHEMISTRY. *First Term:* Chemistry of plants and of their products. Nutrition of plants from atmospheric sources. Inorganic ingredients of plants, their importance and derivation; ash analysis. Physics of plants; mechanism of nutrition and movement of the juices. Germination and development of plants, and accompanying chemical changes. *Second Term:* Chemistry and physics of soils; their origin, formation, classification. Physical properties; their determination and influence; mechanical analysis. Chemical composition; relation to vegetable nutrition. Chemical analysis; its methods, utility and interpretation. Policy of culture and maintenance of fertility; exhaustion of soils by irrational culture; rotation of crops, green-manuring, subsoiling, thorough-drainage, irrigation; manures, their kinds, preparation, use, and value; the rational system of culture. General summary. Johnson's *How Crops Grow*	3	3	3 0, 3	3 0, 3	3	3	6 0, 6	5 0, 5

Mr. Wickson	113	II	Elementary and Economic Entomology. Demonstrations both from type collections and from living specimens. Field and orchard studies of both injurious and beneficial insects, and practical exhibition of the application and effects of various insecticides. Special instruction in the use of the microscope in identifying minute insects injurious to plants, and diseases caused by vegetable parasites	-----	-----	-----	-----	1	1	5 0, 5	4 0, 4
Mr. Wickson	114	III	Agriculture and Horticulture. Stock-breeding, dairying, fruit-drying, and methods of farming. Under the last head attention was directed to methods of culture, farm implements and machinery, practice of irrigation and drainage, and general field crops. The instruction in horticulture extended through the year, touching upon particular topics when they were most seasonable. Stock-breeding and dairying occupied the first term; and dairying, methods of farming, and staple crops, the second term	3	3	2 0, 2	1 0, 1	-----	3	1 0, 1	1 0, 1
Prof. Hilgard	115	IV	Viticulture. A short special Course in the chemistry and analysis of musts and wines, and in practical vinification, is given during the vintage season, from September to the Christmas vacation, in the enlarged and newly equipped Viticultural Laboratory. The lectures were adapted as nearly as possible to the needs of the classes, and were supplemented by daily work in the laboratory	-----	-----	-----	-----	2	-----	2 0, 2	2 0, 2
			MECHANICAL DRAWING AND MAPPING.								
Mr. Kower	116	I	Instrumental Drawing and Descriptive Geometry. Drawing of simple patterns, descriptive geometry, perspective, isometric projection, shades and shadows, etc.	3	3	22 1, 23	16 1, 17	3	3	18 0, 18	14 0, 14
Mr. Raymond	117	II	Mapping. Topographical, mining, and railroad mapping, and topographical modelling	6	6	7 0, 7	6 0, 6	6	6	13 0, 13	9 0, 9
Mr. Kower	118	III	Mechanical Drawing. Drawing of simple machine parts	6	6	6 0, 6	6 0, 6	6	6	11 0, 11	8 0, 8
Mr. Kower	119	IV	Graphostatics. Graphical analysis of stresses in engineering structures	-----	2	9 0, 9	8 0, 8	-----	2	9 0, 9	8 0, 8
Mr. Kower	120	V	Construction. This Course includes the designing of engineering structures and machines	9	9	8 0, 8	8 0, 8	9	9	6 0, 6	6 0, 6

RECORD OF SUBJECTS TAUGHT AND OF ATTENDANCE IN EACH CLASS PURSUING THEM—Continued.

INSTRUCTOR.	Number	No. of Course as given in University Register	TITLE AND DESCRIPTION OF COURSE.	1886–87.				1887–88.			
				No. Hours a Week.		No of Students in Attendance.	No. of Students Passing Final Examination.	No. Hours a Week.		No. of Students in Attendance.	No. of Students Passing Final Examination.
				1st Term.	2d Term.			1st Term.	2d Term.		
			MILITARY SCIENCE.								
Prof. Harrison	121	I	TACTICAL INSTRUCTION IN THE FIELD	2	2	162 0, 162	--------	2	2	185 0, 185	--------
Prof. Harrison	122	II	TARGET PRACTICE	-----	-----	--------	--------	-----	-----	--------	--------
Prof. Harrison	123	III	A BRIEF COURSE IN MILITARY SCIENCE, including engineering and fortifications, strategy and tactics, ordnance and gunnery, military law, courts and boards, modern improvements in the art of war, and a study of great battles	1	1	23 0, 23	23 0, 23	1	1	19 0, 19	19 0, 19

The following table presents a condensed outline of the number of courses actually given, and the average time devoted to each:

	Number of Courses.	
	1886-87.	1887-88.
Extending throughout the year—		
One hour a week	2	2
Two hours a week	12	10
Three hours a week	11	15
Four hours a week	14	14
Six hours a week	2	2
Extending through one term—		
One hour a week	4	2
Two hours a week	14	19
Three hours a week	16	17
Four hours a week	11	10
Six hours a week	2	2
Extending through three terms—		
Four hours a week	1	1
Laboratory Courses ranging in time from three hours to eighteen hours a week	13	13
Total number of courses	102	107

The following courses were offered, but not given for lack of students wishing to elect them, or for other cause :

In 1886-87, Philosophy: XXIII Kant, XXIV Hegel; French: II Advanced Course; Mathematics: VI Theory of Determinants, VII Modern Methods in Geometry; Physics: III Thermodynamics, IV The Physics of Meteorology, V Theory of Vision, IX Galvanism; Chemistry: VII Physiological Chemistry, X Modern Theories in Chemistry; Mineralogy: IV Economic Geology, V Crystallography and Crystallophysics; Botany: VI Advanced Systematic Botany; Civil Engineering: VI Engineering Specifications and Contracts. Fifteen courses.

In 1887-88, Philosophy: IX Ancient Development of Idealism, X Modern Development of Idealism, XXIX Kant, XXX Kant; Greek: V Greek Literature, Lectures; English: III The English Drama, X Advanced Old English; German: II Middle High German; Mathematics: VI Theory of Determinants, VIII Quaternions; Physics: III Thermodynamics, IV Physics of Meteorology, V Theory of Vision; Chemistry: X Modern Theories in Chemistry; Geology: II Petrography, III Economic Geology; Mineralogy: III Crystallography and Crystallophysics. Seventeen courses.

In the foregoing tabular statement of the number of students in attendance upon each course, the difference between the numbers of those there described as in attendance and those passing final examinations includes not only all students who appeared at the examinations and were conditioned, but also all students who for any cause were absent from the examinations. The percentages of those who appeared at the examinations and passed them are as follows:

In 1886–87, sixty-two and four tenths per centum; in 1887–88, sixty-four and four tenths per centum of all those in regular attendance. The highest percentages of failure, as may be seen by a cursory glance at the table, occur in the elementary courses in Mathematics and English. The maximum seems to have been reached in the subject of Trigonometry, where in one class the percentage of delinquents rises to sixty-three in a hundred.

THE UNDERGRADUATE COURSES.

At the time the Dean's report for 1885–86 was being written, it was expected that important changes might be introduced into the curricula of the Undergraduate Courses within the next two years, and for that reason the entire scheme of those courses was inserted in the report. Our expectations have not been realized and the prescriptions and elections in the Undergraduate Courses remain substantially as they were two years ago. It will, therefore, only be necessary, in this connection, to refer you to pages 104–109 of my former report. There have been a few slight changes, but they are for the most part of an unimportant nature, such as the insertion of a new elective, or the substitution of a new for an old one, and presumably they will be explained in sufficient detail in the separate reports of the Professors.

WORK DONE UNDER THE AUSPICES OF SOCIETIES—ASSEMBLY LECTURES.

There still exist at the University, to some extent under its auspices and maintained either wholly or in part by members of the University:

1. The Longfellow Memorial Association.
2. The Political Science Club.
3. The Berkeley Choral Society.
4. The Science Club.
5. The Engineering Club.

1. The programmes of the Longfellow Association have consisted chiefly of essays and public lectures:

In 1886–87, an essay on Goethe, by Albin Putzker; lecture on Edwin Arnold's Light of Asia, by Mrs. Florence Williams; informal lecture on the Mediæval Drama, by F. H. Stoddard; essay on the Poetry of Form, by Miss Mary L. White; Why I Love Burns, address by Robert Mackenzie; Grecian Art, lecture, with stereopticon views, by Arthur M. Knapp; A New Author, essay, by J. H. Senger; The Sonnet in America, essay, by J. C. Rowell.

In 1887–88, five lectures by Mrs. Florence Williams on Dante's Cosmos, Racine's Phédre, Morris' Sigurd the Volsung, and Goethe's Faust; essay, by Horace Davis, on the Sonnets of Shakespeare; a series of five lectures on art, namely: The Mission of Art in Human Life by Charles W. Wendté, Japan as seen by an Artist by Theodore Wores, Landscape Painting by William Keith, Some Thoughts on Art by Fred. Yates, Realism in Art by Emil Carlsen; an Exhibition of the Arundel Collection and of other works illustrative of early painting, through the kindness of W. K. Vickery; three lectures on art, illustrated by stereopticon views, by Sidney Dickinson, namely: The Alhambra, Italian Art, and the Art Treasures of the Czar; lecture, by Oskar Guttmann on Speech and the

Necessity of Training for the Rostrum, Ordinary Life, and the Mimic Art; reading, by Charles Dickens, from the works of his father; lecture on Emerson and Longfellow, by Julia Ward Howe.

2. At the fortnightly meetings of the Political Science Club, papers on the following subjects have been read and discussed: Prohibition vs. High License; Imperial Germany; Representative Government; Knickerbocker and Puritan in the Connecticut Valley; The Data of Mexican Politics; Some of the Political Aspects of Socialism; The Election System; Speculation; Economic Lessons from the Chinese; Growth of Federalism in Switzerland; Nationalization of Land; The Legal Tender Cases; National Control of Railroads; The Protective System; Personal Canvass of Candidates for Office; The Future of Representative Currency; The Abolition of Slavery.

3. The Berkeley Choral Society has continued its weekly rehearsals in Literary Hall, and has given during the academic years, 1886–87, 1887–88, three choral concerts in Assembly Hall, at which have been rendered mostly short classic pieces by Mendelssohn, Schumann, Rheinberger, Brahms, Bruch, Rubenstein, Gade, and others, in addition to Dudley Buck's cantata, The Light of Asia, which constituted the entire programme of one of the concerts. Besides these there have been given, under the auspices of the society, several instrumental concerts conducted by Hermann Brandt, and one lecture on Tonic Sol-Fa by S. B. McBurney. The society has in prospect for the present winter, in addition to its regular concerts, a series of lectures on Musical Forms. H. B. Pasmore has directed the rehearsals and concerts of the society during the past two years.

4. The following papers have been read at the meetings of the Science Club: Some Developments of the Charleston Earthquake, by Joseph LeConte; Ores of Peroxide of Hydrogen, by W. B. Rising; The Nebular Hypothesis, by John LeConte; Extension of some Physical Conceptions, by F. Slate; The New Element Germanium, by E. A. Schneider; Investigation on the Orange, by F. W. Morse; Phenomena of Phantom Vision, by John LeConte; Micro-Analysis, by W. B. Rising; Limitations of the Second Law of Thermodynamics, by John LeConte; Berkeley Oaks and some of their Insect Inhabitants, by J. J. Rivers; Electric Treatment of Wines, by E. W. Hilgard; Methods of Chemical Analysis of Butter, by W. B. Rising; Infinitesimals, Limits, and Rates, by Irving Stringham; Permanence of Climate, by John LeConte.

5. At the meetings of the Engineering Club, papers on the following subjects have been presented: Maintenance of Way, by William G. Curtis, Superintendent of Track and Water Supply for the Southern Pacific Company; Gas Making, by J. B. Crockett, President and Engineer of the San Francisco Gas Light Company; Construction of the San Francisco Seawall, by Marsden Manson, Chief Engineer of the State Board of Harbor Commissioners; Notes on Engineering Work and Works, by A. S. Hallidie, President of the California Wire Works; Analysis of Soil Supposed to Possess the Property of Preserving Wood, by J. A. Chesnut, student in the College of Mining.

In addition to the foregoing discussions, conducted under the auspices of University societies, there have been given in Assembly Hall, by invitation of the President or the Academic Council, the following lectures: Four lectures on the Religious Drama of the Middle Ages, by F. H. Stoddard, Instructor in English in the University; a lecture on the Identification of the Landfalls of the Early Navigators on the Coast of California, by George Davidson, of the United States Coast Survey, and Honorary Professor of Geodesy and Astronomy in the University; a lecture on the Battle of Gettysburg, by General O. O. Howard.

STUDENT SOCIETIES.

In conclusion of this report I desire to call attention to the present condition and aims of the recently organized Durant-Neolæan Society and the Students' Coöperative Association. Each of these societies, if properly conducted, can be made to serve important student interests, and a friendly coöperation on the part of the University authorities appears to be desirable. Mr. Edelman, President of the Durant-Neolæan Society, and Mr. Sturtevant, Manager of the Students' Coöperative Association, have, in response to my request, handed me the following memoranda:

"The Durant-Neolæan Society, formally organized on November 24, 1887, derived its charter members, as may be inferred from its name, from the two old literary societies, the Durant and the Neolæan, which at that time, although not wishing to be called defunct, were almost so in reality. There had been a desire among the members of these societies to form—according to a suggestion thrown out by Dr. Levermore—a Students' Congress; and since this could only be successfully wrought out by coöperation, a good cause for uniting was found; and the fact that the Durant and Neolæan Societies were both inactive, greatly hastened the movement.

"Accordingly a Students' Congress was formed under the guidance of the Durant-Neolæan Society; that is to say, all members of the new society were members of the Congress, and the latter was simply a programme of the former, twice each month; while a third monthly meeting of the society, at which the old style literary programme was presented, was held. At present, however, the meeting of the Students' Congress forms each programme. This form of meeting was desirable in that the old names of the societies could be kept, and minor transactions could also thereby be greatly facilitated, since they would be carried on by the society proper, which has a set of officers distinct from those of the Congress.

"The formation of the Congress is somewhat mixed. The introduction of all bills, which, by the way, are such only as it is competent for the Congress of the United States to pass, is made by a Ministry, the leader of which is appointed by the Speaker—the elected presiding officer. Upon the defeat of any motion made, or bill presented by them, the Ministry retires, to make room for the leader of the opposition and his associates. Certain rules have necessarily been laid down, whereby the Congress is governed, but these are few, and the rules and regulations of the United States Senate are followed, where they do not conflict with those adopted by the society.

"The first bill presented was 'A bill to regulate naturalization.'" This passed. Two bills have been presented by the existing Ministry, the first a copy of the Mills bill, the second a bill amending the Constitution of the United States, so that hereafter the President may be elected by a popular vote. This latter bill is still pending.

"The Durant-Neolæan Society at present consists of about sixty members, selected from all classes. A large membership is highly desirable, and eager debate is recommended. The Congress is yet an experiment, but so far has proven very successful. A hall for regular meetings, conveniently and appropriately fitted up, is needed; and with increasing interest among the members, the society and its Congress must surely grow."

When, in 1883, the Students' Coöperative Association was founded, much doubt concerning its usefulness and its future was expressed by many students. Only fifteen could be found to enter into the scheme with any enthusiasm. A few principles, thought necessary to its success, were formulated into a constitution and by-laws, in the preamble of which the object of the Association was stated to be the furnishing supplies to students at wholesale rates. At first only text-books and stationery were included in its transactions, but its business operations have recently become considerably enlarged, and at present extend to the furnishing of books and stationery of all kinds, assayers' supplies, military and gymnasium suits, and, indeed, everything purchasable that a student may need. The cost of these things to the purchaser is the San Francisco wholesale price, plus a small percentage necessary to pay freight and the general expenses of the Association, and a membership fee of $2 50, paid once for all. During the first few years the society's commission was ten per centum, but at present it is only five, and sometimes much less.

In order to realize the best results of the scheme, the cordial coöperation of the entire student body and of the members of the Faculties is necessary. With the patronage of the entire University it would be possible to so increase the business of the Association as to insure the obtaining of special rates direct from publishers and manufacturers. Experience has shown that, even in such commodities as uniforms and gymnasium suits, a considerable saving can be made to the student through the agency of the Coöperative Association.

The business of the year 1886-87 amounted to $3,681 65; last year this amount was increased by one half, and the business of the year 1888-89 will not fall much short of $7,500. About four thousand books have been distributed by the Association during the past two years. This estimate includes a few books which were sold to persons not connected with the University, who were charged the regular retail price of the goods.

Respectfully submitted.

IRVING STRINGHAM,
Dean.

LETTERS AND LANGUAGES.

Philosophy.

To the President of the University of California:

Sir: In reply to your circular I have the honor to submit what follows.

The only changes that have occurred since the autumn of 1886 consist in some re-arrangement of the hours assigned for instruction in the undergraduate classes. According to the "Course of Instruction" adopted for the Department by vote of the Academic Senate, November 5, 1884 (the full details of which may be found in the Biennial Report of the President of the University, 1884), the instruction in philosophy began in the Sophomore year, with a course of lectures given once a week. Experience has proved that more efficient instruction will be given by concentrating the time thus assigned to the Sophomore year upon the courses provided for the Junior year, making the instruction in that year four hours a week, instead of the three hours provided for in the original "Course of Instruction" already referred to. Accordingly, a resolution was presented to the Academic Council, June 6, 1888, discontinuing the Sophomore course in philosophy, and making the Junior courses consist hereafter of four lectures a week during each term of the academic year; the resolution was adopted by the Council and confirmed by the Academic Senate at its regular meeting in November. A change similar in purpose was at the same time proposed regarding the courses provided for the Senior class. The original "Course of Instruction" allotted three distinct courses of lectures to the Senior class each term, each of two hours a week. The six hours thus assigned are by the new proposal distributed into *two* courses, one of four hours a week and the other of two. This proposal was also adopted by the Council and likewise confirmed by the Senate.

The instruction this year (1888-89) has been conformed to these changes.

A change in the hours for the course offered annually to graduate students, from three a week to four a week, has also been adopted by the Council, and confirmed by the Senate.

The entire new arrangement of lectures in the Department may be seen in the scheme subjoined:

Course of Instruction in the Mills Professorship of Philosophy, as amended by the Academic Senate, November 21, 1888.

COURSE I. PROPÆDEUTIC TO PHILOSOPHY. Empirical psychology, including formal logic, deductive and inductive. *Four times a week during the first term of the Junior year.* Open to all students in Junior standing.

COURSE II. INTRODUCTION TO PHILOSOPHY. History of European philosophy, in outline. *Four times a week during the second term of the Junior year.* Open to students who have completed Course I.

COURSE III. ELEMENTARY ETHICS, INCLUDING CIVIL POLITY. Sketch of the history of ethical and political theories; critique of the conflict between perfectionism and hedonism, freedom and necessity, optimism and pessimism; investigation of the nature of a state and of its bearing on the limits of liberty and allegiance. *Four times a week during the first term of the Senior year.* Open to students who have completed Course II.

COURSE IV. FIRST ALTERNATING COURSE. Exposition of some principal movement or conflict in the history of philosophy, by a critical study of its leading participants; or the like, the subject being changed from year to year. *Twice a week throughout the Senior year.* Open to students who have completed Course II.

COURSE V. SECOND ALTERNATING COURSE. Some additional topic, similar to that of Course IV, and similarly changed, but drawn, preferably, from the field of practical philosophy. *Four times a week during the second term of the Senior year.* Open to students who have completed Course III.

COURSE VI. GRADUATE COURSE. First-hand study of certain philosophic masterpieces, such as Plato's *Parmenides*, *Theætetus*, and *Sophist*, Aristotle's *De Anima*, Kant's *Kritiken*, or Hegel's *Phænomenologie des Geistes*; etc. *Four times a week throughout the year.* Open to graduates having the necessary acquaintance with the elements of philosophy, and the requisite knowledge of the languages in which the works are written.

As to the present needs of the Department, they are briefly two,—an increase in the library resources available for it, and an increase in the teaching force. These needs, and the grounds of them, are clearly pointed out in the last Biennial Report of the President of the University. [See Biennial Report, 1886.]

I will here only call attention to the importance of giving the head of the Department sufficient release from the more elementary teaching to admit of his providing a greater variety of advanced work, particularly in the development of graduate instruction. Under the present conditions, there is more to do than a single officer of instruction can adequately attend to. Applications from graduate students are coming in every year, and the highest interests of the University require that an ample provision shall be made for satisfying these, and for inviting their constant increase. As the Department, so far as instruction is concerned, has hitherto been no charge whatever upon the general fund of the University, it may not unreasonably ask that, in view of the universally acknowledged importance of its subject in the curriculum of the College of Letters, and the very numerous attendance of its courses, an appropriation should be made to it from that fund. A salary of $2,400 a year would probably be sufficient to secure the services of a competent Assistant Professor of Psychology and Logic.

The fact that the Department, on beginning operations in the autumn of 1884, found hardly anything in the University Library to represent its literature, while the other Departments had for years been applying their portions of the library income to the purchase of books appropriate to them, thus leaving this Department far in the rear, makes it reasonable to ask that, for a few years, a larger portion of the income available for the purchase of books be assigned to it than to the others. Could the sum of $500 or $600 be allotted to it this year, for example, so as to collect at once certain works of great and present importance, the Department might then, without relative embarrassment or inequality, go on in subsequent years with the proportional allotment coming to it regularly in common with the rest. Another thing: the Library Committee of the Board of Regents should be respectfully and urgently requested to adopt some plan of so disbursing a portion of the annual allotment that important new books may be obtained promptly on their appearance. Under the existing arrangements, a delay of a whole year is usually necessary. This is a matter in which all the Departments are equally concerned.

Meanwhile, it would add greatly to the efficiency of the books already at the service of the Department, if a duplicate card-catalogue of all the works on philosophy in the Library were made, and kept in the philosophical lecture-room. It is to be hoped that this may soon be ordered done.

Respectfully submitted.

G. H. HOWISON,
Mills Professor of Intellectual and
Moral Philosophy and Civil Polity.

History and Political Science.

To the President of the University of California:

Sir: The instruction in the Department of History and Political Economy, as at present organized for the undergraduate classes, aims, in the first place, to lay the foundation for special study in history and political science; in the second place, to furnish such information as will afford a suitable preparation for the intelligent performance of the public duties of a citizen. This instruction is embraced under the following ten courses:

I. English History. The general history of England; special attention, however, being directed to the history and political institutions of England in the seventeenth and eighteenth centuries.

II. European History. The history of continental Europe from the fifth century to the Congress of Vienna.

III. United States History. (*a*) The social, political, and constitutional history of the Colonies.

(*b*) History of the Revolution, of the Government under the Articles of Confederation, and of the formation of the Constitution; Principles of Constitutional Law.

(*c*) Political and constitutional history from 1789 to 1860.

IV. Comparative Constitutional History. A comparative view of the development and present condition of the political institutions of the Western nations.

V. History of the Nineteenth Century. A study of the principal social and political movements since the Congress of Vienna.

VI. Political Economy. A general view of the principles and laws of Political Economy in its present position.

VII. Advanced Political Economy. A critical study of the history of economic thought.

VIII. Roman Law; Jurisprudence. History of the development of the public and private law of the Romans; systematic and historical exposition of Roman Law, with comparative views of the chief modern systems; the science of Positive Law.

IX. Constitutional Law of the United States. Critical study of the leading judicial decisions on the Constitution.

X. History of Political Theories. The history of political thought and its practical influence on institutions.

Of subjects that should be taught in this Department, but are not, because of inadequate teaching force and facilities, two especially demand attention: 1. Finance; 2. The History of Antiquity, with special reference to the development of ancient civilization. In view of the fact that many students complete an undergraduate course without having their attention called to ancient civilization through the study of ancient languages, it is necessary that some other means should be instituted to give them acquaintance with the art and life of those nations who were the intellectual ancestors of all modern civilized nations. It is hereby recommended that arrangements be made for giving instruction on these subjects.

For the successful execution of the work already undertaken there exist the following imperative wants:

1. Books and maps. These are apparatus essential to instruction in this Department. What instruction in chemistry would be without a laboratory and its proper equipment, that, in a very great measure, is instruction in history without maps, general and special, and books containing the authorities, in which the students may expand and verify their information. It is, therefore, hereby recommended that a proper amount be appropriated from the funds of the University for the purchase of such books and maps as are specially required in carrying out the established courses of instruction in history.

2. Rooms with chairs, facilitating note-taking. At present the rooms that may be used by this Department are inadequate to the needs, and the chairs in the rooms that may be used are ill-suited to the purposes of the lecture room.

Respectfully submitted.

BERNARD MOSES,
Professor of History and Political Economy.

Greek.

To the President of the University of California:

Sir: In accordance with your request I would report as follows concerning the needs of the Department of Greek:

It is very essential that Greek texts should be procured for use in the entrance examinations and for sight reading and examinations in the University classes. The two examinations for entrance each year require eight distinct examination papers, each containing a portion of a Greek author in the original. By the employment of these texts in the entrance examinations, the Greek necessary to be printed will be reduced to such Greek words as occur in the questions. A material reduction of the expense of printing the papers for these examinations will thus be effected. The following list contains the texts necessary for the entrance examinations. They are published by Teubner, in Leipzig, and are the cheapest to be had.

	Marks.
30 copies of Xenophontis historia Graeca, @ M. —.90	27.00
30 copies of Plato, Abteilung I, @ M. —.60	18.00
30 copies of Xenophontis Anabasis, @ M. —.75	22.50
30 copies of Homeri Ilias, Pars I, @ M. —.75	22.50

It is the policy of the Department of Greek to occupy as much time as possible in the class-room in reading at sight Greek that has not been studied by the class; and, further, to make the student's advancement from one class to another depend largely upon his ability to read Greek at sight in the examinations. The following list contains the texts necessary for the examinations in the University classes, and for sight reading in the class-room:

	Marks.
25 copies of Xenophontis commentarii, @ M. —.45	11.25
13 copies of Herodoti, Vol. I, Lib. 1-4, @ M. 1.35	31.25
12 copies of Herodoti, Vol. II, Lib. 5-9, @ M. 1.35	
13 copies of Odyssea, Pars I, I-XII, @ M. —.75	18.75
12 copies of Odyssea, Pars II, XIII-XXIV, @ M. —.75	
13 copies of Thucydides, Vol. I, Heft 1, @ M. 1.50	37.50
12 copies of Thucydides, Vol. II, Heft 2, @ M. 1.50	
13 copies of Plato, Abteilung V, @ M. —.60	15.00
12 copies of Plato, Abteilung VIII, @ M. —.60	
13 copies of Demosthenes, Vol. I, Pars I, @ M. —.75	18.75
12 copies of Demosthenes, Vol. II, Pars I, @ M. —.75	
20 copies of Aeschyli tragoediae, @ M. 1.20	24.00
13 copies of Euripidis tragoediae, Vol. I, @ M. 1.50	37.50
12 copies of Euripidis tragoediae, Vol. II, @ M. 1.50	
20 copies of Sophoclis tragoediae, @ M. 1.50	30.00
20 copies of Lysiae orationes, @ M. 1.20	24.00
10 copies of Aeschinis orationes, @ M. —.90	9.00
5 copies of Aristophanis comoediae, Vol. I, @ M. 1.50	15.00
5 copies of Aristophanis comoediae, Vol. II, @ M. 1.50	
Total	M.352.00
Deduct 20 per cent allowed to University Library	70.10
	M.281.90
Estimating the mark at 25 cents	$70 47
Binding, estimated by the Librarian at 12½ cents per volume	46 87½
Total cost of texts	$117 34½

It is my intention to offer to the classical students of the upper classes a series of readings of other portions of the Greek authors than those read in the Greek course. These readings, supplemented by brief lectures and explanations, will be given in the evenings, or at such other times as may be found convenient, and will form an addition to the required work in Greek. It is indispensable that the student should have the Greek before him during these exercises, and these texts will give an opportunity for this.

Let me call your attention to the service rendered Greek scholarship by the American School of Classical Studies at Athens. Opened in 1882 by the joint efforts of certain American colleges, it has steadily prospered up to the present time. The object of this school is "to furnish to graduates of American colleges an opportunity to study classical literature, art, and antiquities in Athens, under suitable direction; to prosecute and to aid original research in these subjects; and to coöperate with the Archæological Institute of America, as far as it may be able, in conducting the exploration and excavation of classic sites." The school is now under the charge of a permanent director, Dr. Chas. Waldstein, and owns in Athens grounds, a building, and a library.

The privileges of this institution are offered to all Bachelors of Arts of those colleges that contribute to its maintenance, and to all their post-graduate students that have received the degree of A.B. All the leading colleges and Universities of America assist in its support, each giving the sum of $250 annually, and I earnestly recommend that the University of California secure in the same way for its students the inestimable opportunity offered by this foundation for broadening and vivifying their scholarship.

Respectfully submitted.

GEORGE WOODBURY BUNNELL,
Professor of the Greek Language and Literature.

Latin and Philology.

To the President of the University of California:

Sir: During the past two years no important changes have been made in the Department of Latin, either in the method of instruction or in the subject-matter of the courses.

At the beginning of this period, the *De Officiis* of Cicero was added to the regular work of the Sophomore year, but, with this exception, the same authors have been read, and only slight changes have been made in the selection of works from the authors.

The number of students in the several courses has varied considerably. The number presenting themselves for the examinations in the various courses is shown in the following table:

	1886–7.		1887–8.	
	First Term.	Second Term.	First Term.	Second Term.
Freshmen, Course I	48	42	36	34
Sophomores, Course II	22	21	28	27
Juniors, Course III	16	15	13	15
Seniors, Course IV	3	11	15	15
Archæology, Course V	------------	12	------------	9
Literature, Course VI	5	------------	4	------------
Linguistics	15	------------	9	------------
Comparative Philology	------------	10	------------	5

This Department seriously needs the full time of two instructors. With Freshmen and Sophomore sections of the size here indicated, the time of one instructor is or should be fully occupied; but when to this is added the greater part of the work of the Recorder's office, the class work must necessarily suffer in consequence.

The Department is further seriously impeded in its effectiveness by the lack of wall maps, and there should be at once provided Kiepert's wall maps of Italy, Rome, Greece, Asia Minor, and Spain.

There should further be immediately provided in the library certain standard works of reference for the study of Roman Archæology and Literature, which ought not properly to come out of the meager annual appropriation of this department for the purchase of books. As the least which should be done in this respect, I would suggest the purchase of Marquardt & Mommsen's Handbuch der Römischen Alterthümer, such volumes as have already appeared of Iwan Müller's Handbuch der Classischen Alterthumswissenschaft, Overbeck's Pompeji (fourth edition), Teuffel's Römische Literaturgeschichte (there is an English translation, but the German original is later and preferable), Ribbeck's Römische Tragoedie, and Vanicek's griechisch-lateinisches etymologisches Wörterbuch. (Knowledge of German is not absolutely essential to the use of the last of these books.)

I wish here to emphasize the importance of the study of German for all students of Latin and Greek. The latest monumental works on Roman Literature and Archæology are in that language, and have not been (probably will not be) translated into English. The classical student finds himself constantly confronted by problems which even a fair knowledge of German would enable him easily to solve, and, aside from the fact that German plays a very important part in the comparative study of language, the chief works relating to the science of language are in German.

Respectfully submitted.

ALBERT A. HOWARD,
Professor of the Latin Language and Literature.

ENGLISH.

To the President of the University of California:

SIR: The progress of the Department of English during the past two years has been largely due to the wisdom of the Regents in appointing an Instructor. Two advantages, or rather three, resulted from this action: the Freshman class was brought into closer relations with the instructor in themes, and, since the Professor and Assistant Professor were relieved from a certain amount of drudgery, all were enabled to plan and prepare for additional courses, and to publish the results of original investigation. Each of these advantages may demand a word of explanation.

And first, the Freshman year is the only one in which systematic class-room instruction in English is given to all, or nearly all, of the regular students in the University. After that period, the students divide, some continuing this subject, and others being diverted from it by their own choice or the necessities of their course. Hence it is imperative that this year be devoted to that branch which is indispensable to all, the study of prose style as exemplified by certain modern masters. All will have occasion to write, and therefore to all the mechanism of prose writing must be displayed, and some of the secrets of strength, simplicity, and grace revealed. But such theoretical instruction would be of comparatively little value, were no practical application made of the principles to which attention has been directed. Practice in writing is therefore insisted upon, and the intervals between successive papers are made so short that ease is bred by habit, and the theme ceases to be a far-off bugbear to be dreaded, and, if possible, to be avoided. Now it is evidently important that the instruction in theory and that in practice should be coördinated, and this requires that they shall, as far as possible, be in the hands of the same individual. By the appointment of a full Instructor, to take the place of an assistant who had charge of Freshman themes only, this substantial benefit accrues to the largest class in the University, at the moment when its members are most susceptible, and most in need of guidance.

The second advantage consists in the multiplication of elective and optional courses. The field covered by the English language and literature is vast. No one can be equally familiar with all parts of it. Hence, to give an interesting and profitable course, extending over a whole term, in an author or subject not hitherto included in the general scheme, may, and generally does, require extensive study and preparation. The actual effect of the appointment of an instructor was that, whereas the Register for 1886–87 shows ten courses offered in English, that of 1887–88 has thirteen; the new courses being one in the English Drama, offered as a Junior optional by Mr. Stoddard; one in Burke, offered as a Junior elective by myself; and one in Milton, offered as a Senior elective by myself. For the present term, Assistant Professor Bradley offers a Junior optional in The Novel, and I offer a Senior elective in Longfellow's Translation of Dante, in addition to courses given previous to 1887–88.

Under the third head, that of original work, reference may be made to the lists of publications appended to the President's Report. Nor has such production been confined to the teaching force of the department. Frank Fischer, a graduate student pursuing English courses, has completed a piece of work which has been accepted for publication by *Modern Language Notes*, a periodical which appears under the auspices of the John Hopkins University; and the names of George D. Boyd, Fanny Cooper, Alice K. Grover, Adolph C. Miller, and Catharine E. Wilson have already been mentioned in my preface to *Judith, an Old English Epic Fragment* (Boston, 1888).

The schools and the public have not yet fully responded to the demand on the part of the University for better preparation in English. The evil will never be fully cured until Grammar School instruction in the subject is made much more thorough than at present, a consummation which may safely be left to the zeal and good judgment of the public, who will not long permit that the vast majority of children shall be allowed to graduate from the Grammar Schools without the ability to write a neat, correctly spelled, and well-worded letter. On the whole, the outlook is hopeful, and will be still more so when no teacher of English receives a High School appointment without presenting guarantees of special training and fitness for so responsible a position.

The most pressing needs of the Department are, as I conceive, better class-rooms and better salaries. The main room now used by all three instructors in common is cheerless, unattractive, and crowded by our largest classes. As to salaries, the present provision of $1,500 for the Instructor, and $1,800 for the Assistant Professor, is, in my judgment, quite inadequate. No men capable of discharging, in an acceptable manner, the duties appertaining to these two posts, ought to be offered less than $1,800 and $2,400 respectively, sums no more than sufficient, considering the expensiveness of living on this coast, for suitable maintenance, the purchase of needful books, and the provision of needful recreation.

Respectfully submitted.

ALBERT S. COOK,
Professor of the English Language and Literature.

GERMAN.

To the President of the University of California:

SIR: Permit me to submit an *informal* memorandum touching the Department of the German Language and Literature.

1. The total number of persons receiving instruction at present in the different classes is one hundred and fifty—a larger percentage than ever before in the history of the University, I think.

2. The spirit of the students is excellent and in sympathy with a high literary aim.

3. Mr. J. Henry Senger, Ph.D., was appointed Instructor in this Department September 1, 1886 (since the last report).
4. An elective course in Middle High German has been added.

NEEDS AT PRESENT.

1. That Mr. Senger give all his time to this department.
2. That his salary be raised; his present pay does not nearly suffice for the wants of a gentleman and his family.
3. A study room for the Professor.
4. A small library of reference, in particular, a copy of Grimm's Wörterbuch der deutschen Sprache. The copy in the German Library is not handy enough for class-room use.

Respectfully submitted.

A. PUTZKER,
Professor of the German Language and Literature.

French and Spanish.

To the President of the University of California:

Sir: In compliance with your request, I will indicate certain conditions creating what seem to me pressing needs in my Department.

A year and a half ago, when I took charge, there were no classes of Seniors and Juniors; and though now the members in these classes are few, the hours are many and crowd the hours of the lower classes. Of the Sophomore and Freshman classes the numbers are large, of the latter very large, being more than thirty and sixty, respectively; and among the students of each of these classes there are differences in the degree of preparation, which work serious injustice to some. The differences are due, first, to the fact that those in the Classical and Literary Courses are far better prepared for instruction than those in the Scientific Courses, and, second, to the greater or less acquaintance of the students with French or Spanish on entering the University. On the basis of these differences, the classes need very much to be divided, and to this end an additional Instructor should be appointed.

Respectfully submitted.

F. V. PAGET,
Instructor in French and Spanish.

GENERAL SCIENCE.

Mathematics.

To the President of the University of California:

Sir: In response to your request for a formal report on the changes that have taken place in the Department of Mathematics during the past two years and on its present needs, I beg leave to submit the following:

During the past two years, in addition to the courses in the elementary subjects of Algebra, Solid and Spherical Geometry, Trigonometry and Analytic Geometry of the Conic Sections, all of which are prerequisite for the Bachelor's Degree in reputable American colleges, courses have been given, under the direct management of the mathematical Department, in the following higher branches:

In 1886–87, (1) Analytic Geometry of Space, (2) Differential and Integral Calculus, (3) Differential Equations, (4) Quaternions.

In 1887–88, (1) Analytic Geometry of Space, (2) Differential and Integral Calculus, (3) Differential Equations, (4) Modern Geometry, (5) Advanced Analytic Geometry and Curve Tracing.

A course in Theory of Determinants was offered at the opening of the first term, both in 1886 and 1887, but the number of students offering to elect it did not warrant its being given. For a like reason the course in Modern Geometry was omitted in 1886–87, and the course in Quaternions in 1887–88.

Detailed statements of the topics treated in these courses, the number of students pursuing them and the text-books used are given in tabular form in the Dean's report, and need not be repeated here.

This scheme does not differ in its essential outlines from that which was sketched and put into operation four years ago; but some of the details of it, especially as regards methods of instruction, have undergone important changes. The parts of it that form the mathematical basis of the courses in Engineering, and to which all the others have been subordinated, include the subjects of Algebra (of which elementary Determinants and the Theory of Equations form a part), Geometry (Solid, Spherical and Projective), Trigonometry, (Plane and Spherical), Conic Sections, Analytic Geometry of Space, Differential and Integral Calculus and Differential Equations, and it has been the chief concern of the Mathematical Department to make the instruction in these subjects thorough and effective. In order to give a true account of the changes which have led to the present methods of doing this work, it will be necessary to recount a bit of history.

Up to the time of the entrance examinations in 1879, the mathematical requirements for admission to any one of the Colleges at Berkeley had included Arithmetic, Algebra to Quadratic Equations, and the first four books of Davies' Legendre. In June of that year, after less than a year's previous announcement, the requirements for entrance to the Scientific Courses were increased so as to include the whole of Solid and Spherical Geometry, and in the following June, after less than two years' announcement, they were still further increased by the addition of the remaining parts of Algebra, as far as the Theory of Equations.

Up to that time the mathematics of the Scientific Undergraduate Courses had extended through three years, ending at the close of the Junior year with the Integral Calculus and the Calculus of Variations. In consequence of the increased requirements for admission the time allotted to the mathematics of the Scientific Courses was, in 1880–81, curtailed by a year. But in September, 1881, a resolution of the Faculties was passed reducing the requirements in Algebra and Geometry to "Algebra through Quadratic Equations" and "Plane Geometry," so that in 1882 the Freshman Class entered on the old requirements plus Quadratic Equations and one book of Plane Geometry.

The time allotted to mathematics in the Undergraduate Scientific Courses was, however, left as it had been fixed the year previous, and no change has taken place in this allotment since that time, if we except the course in Differential Equations, two hours a week for a year, recently made compulsory to Juniors in the College of Mechanics. The urgent problem, however, how to put into two years a thorough training in Algebra (including elementary Determinants and the Theory of Equations), Solid, Spherical and Projective Geometry, Plane and Spherical Trigonometry, Analytic Geometry of Conic Sections, Differential and Integral Calculus and Analytic Geometry of Space, with an average of less than five recitations a week, has been pressing for solution from that day to this, nor has it been as yet solved to our satisfaction.

The good student will thrive under any system of competent instruction, but the student of only average ability, if he be crowded too hard, will not thrive unless special efforts are put forth by his instructor in his behalf. It was in order to keep the average student upon his feet that a series of changes in our methods of instruction was begun, which has finally resulted in substituting for one of the hours of recitation in each of several subjects, three hours of exercises to be worked at sight by the students, usually in sessions of an hour and a half, under the guidance of an instructor. The subjects of Differential and Integral Calculus and Analytic Geometry of Space have been taught in this way during the past two years, the subjects of Trigonometry and Analytical Conic Sections, during the past year.

An important adjunct of our method is the hour or hour-and-a-half test-examination, occasionally substituted for the semi-weekly exercise. In this examination a large number of questions—say twenty or thirty—is given out and a limited amount of time—a few minutes only—is allotted for the working of each example. If the work is done at the blackboard, as it sometimes is, the results are taken account of by the instructor on the spot, but if on paper, they are scrutinized afterwards and handed back to the students with corrections. The insertion here of the complete details of this work would make this report much too long, but I have filed in the Recorder's office a description of them as a part of the record of examinations.

This experiment has produced good results, and the method would be applied to other classes, but we have gone as far in that direction as is possible with our present staff of mathematical instructors, and it is doubtful if we can continue the work already begun without additional aid, inasmuch as the members of the Mathematical Department are all at present working beyond the ordinary limit of strength and time, and should further demand for higher courses arise, the choice will have to be made between refusing to give them and curtailing the time now devoted to elementary drill in the lower classes. For in fact, these sight exercises are at best elementary drill in the ordinary essentials of the mathematical part of the Courses in Engineering, and should be conducted by an assistant—say a graduate student assistant—under the guidance of the Professor in charge. It goes without saying that the time of a Professor, or an Assistant Professor, should be given to higher work when higher work is demanded. One of the most pressing needs of the Department, therefore, is the appointment of a Professor's assistant, to be employed in carrying out the details of this elementary drill.

But in spite of the increased efforts that have been made on behalf of the students in the Engineering Courses, it is still true that many of them reach their Junior year with much of the mathematical food they have consumed but poorly digested, clearly indicating that their intellectual stomachs have been overcrowded, and the same is true, though less seriously so, of many students in the other courses. We find it necessary, therefore, to turn in another direction for their relief. The secondary schools can and will help us out of our difficulty. Already, with but one exception, the High Schools whose graduates are admitted to the University on the recommendations of their Principals, have included in their mathematical courses the subject of Solid and Spherical Geometry, and an advanced section of seventeen students who entered in September of this year with this additional subject to their credit, has been formed in the University. This is sufficient to make it certain that we can now announce that Solid and Spherical Geometry will shortly be required as a preparatory subject of all candidates for admission to any of the Scientific Courses, without danger of being compelled to retrace the step taken. Simultaneously with this change the requirements for admission to all other regular courses should be increased so as to include Algebra through Quadratic Equations, and all of Plane Geometry. There should be no hesitation in making these announcements at once. I know of but one college of good repute in America where the mathematical requirements for admission, either for the Classical or Engineering Courses, are so low as they are in the University of California, and many of the small colleges throughout the country have a better standard in this particular than we. (See the table at page 18, of the Biennial Report of the President of the University, of the year 1886.)

Before closing the part of this report which relates to courses of instruction, I wish to reiterate a conviction, often expressed to my colleagues, that where it can be done with the resources at hand, opportunity for the pursuit of higher courses in physical and mathematical science, during the Junior and Senior years, should be offered in some systematic form, through regular alternatives, to those students in the Colleges of Engineering who are now forced to seek it in the roundabout way of becoming students at large. The Committee on Curricula, in its report presented to the Academic Council a year ago, formulated a scheme in which such courses in mathematics and physics had a place, but there is no immediate prospect that the recommendations of this report will be taken into consideration, and meanwhile I recommend that there be offered, at the beginning of the next academic year and until further notice, the following course of prescribed and elective studies, to be elective as a whole alternatively with the prescribed and elective work of the Sophomore, Junior, and Senior years in the College of Mechanics. All of the courses laid down in this scheme can be given with the resources at hand and without additional expense to the University. In fact, with the exception of the subject of Determinants in the Sophomore year, the courses are all offered for the year 1888–89, and, with one or two possible exceptions, will all be given.

Proposed Second Alternative Course in the College of Mechanics.

Sophomore Year.	1st Term.	2nd Term.	Junior Year.	1st Term.	2nd Term.	Senior Year.	1st Term.	2nd Term.
ENGLISH:			ENGLISH:			ENGLISH:		
History of English Literature	(3)	--------	Shakespeare	(3)	--------	Chaucer and Middle English	(3)	--------
English Classics	--------	(3)	Burke	--------	(3)	Longfellow's Dante	(3)	--------
Themes	***	***	Old English	--------	(3)	Advanced Old English	--------	(3)
			Themes	* *	* *	Milton	--------	(3)
						Themes	* *	* *
GERMAN:			GERMAN:			GERMAN:		
Introductory Course	(4)	(4)	Goethe	(2)	(2)	Lessing	(2)	(2)
FRENCH:			FRENCH:			FRENCH:		
Introductory Course	(3)	(3)	Advanced Course	(2)	(2)	Advanced Course	(2)	(2)
MATHEMATICS:			MATHEMATICS:			MATHEMATICS:		
Calculus	3	--------	Advanced Calculus or Differential Equations	2	2	Differential Equations or Advanced Calculus	2	2
Analytic Geometry of Space	--------	3						
Determinants	2	--------	Advanced Conic Sections	2	2	Higher Plane Curves or Invariants	2	2
Modern Geometry	--------	2	Analytic Mechanics	4	4			
CHEMISTRY:			Method of Least Squares	[2]	--------	Quaternions	2	(2)
			Graphostatics	--------	[2]	Hydrodynamics	(4)	--------
Inorganic	(2)	(2)				Kinematics	(2)	(2)
						ASTRONOMY:		
Laboratory.			ZOOLOGY:			General	3	--------
Mathematical Exercises	3	3	Comparative	2	2	Practical	--------	(3)
						GEOLOGY:		
CHEMISTRY:						Structural and Historical	3	3
Qualitative Analysis	(12)	(8)						
MECHANICAL DRAWING:			*Laboratory.*			*Laboratory.*		
			Mechanical Drawing	(6)	[6]	Physical Problems	(6)	--------
Drawing and Descriptive Geometry	(3)	(3)	Physical Problems	--------	3	Astronomical Observatory	--------	(6)

Note.—Figures denote the number of hours a week; figures in parentheses denote elective subjects; figures in brackets optional subjects.

The classes of students who might be expected to elect the alternative course here outlined are the following:

1. Those who, intending to make mathematical research their special vocation, wish to continue their mathematical studies after graduation, whether here, or in one of the Universities of Europe, or of the Atlantic States.
2. Those who wish to equip themselves as teachers of mathematics.
3. Those who, intending to make physical research (theoretical or practical) their chief occupation, wish a thorough mathematical preparation.
4. Those who, intending to become mechanical, mining, civil, or marine engineers, wish a more thorough mathematical training than is possible in the short time allotted to mathematical study in the *regular* undergraduate courses in the engineering Colleges.

In reference to the further needs of the Department, I beg leave to say, that equally as important as the appointment of a Professor's assistant, is an increase in the amount of the annual appropriation for the purchase of mathematical books. The sum now regularly appropriated—about a hundred dollars—is inadequate to supply all of the important new publications of the year, and the whole appropriation has frequently to be applied to the purchase of a single work, and for the completion of each of several important sets of serials, not yet contained in the library, it falls considerably short of the necessary amount. I do not dwell on this item for the purpose of making complaint, for I believe the Mathematical Department receives its proper share of the Reese Fund, but in order to suggest the propriety of increasing the annual appropriation for the purchase of books out of the general University income.

Finally, there remains still the need for a collection of mathematical models, cost, about $1,000, an item included in the recommendations of the President's report for 1886. (See page 71.) This, however, is not a pressing need, as compared with the others.

Respectfully submitted.

IRVING STRINGHAM,
Professor of Mathematics.

PHYSICS.

To the President of the University of California:

SIR: In accordance with the request contained in your circular of the twenty-second of October, 1888, I herewith submit the following concise report:

(A) CHANGES.

1. In Experimental Physics, during the past two years, the liberality of the State Legislature has furnished a large and valuable increase in the appliances for instruction, in the form of numerous and delicate physical apparatus, many of them being instruments of precision. The details of these accessions to the physical apparatus of the University will be found in the report of the Secretary of the Board of Regents.
2. With regard to assistance in Experimental Physics, there has been, during the past two years, an increase from *one half* the time of one assistant to the *whole* time of an assistant.

3. In relation to the physical laboratory, there has been, during the past two years, no sensible addition to the appliances for instruction, in the way of physical apparatus. In the way of assistance, there has been an increase from no previous assistant to *one half* the time of an assistant.

(B) NEEDS.

1. In order that the various forms of physical apparatus may be interchanged, and utilized both in the lecture-room for Experimental Physics and in the physical laboratory, it is very desirable, and, in fact, quite essential, that the lecture-room for Experimental Physics and the physical laboratory should be in the same building and in convenient juxta-position.

2. More space is needed for the proper storage of the increase in the physical apparatus, which has been secured for illustrating Experimental Physics.

3. There is urgent need for more space for the physical laboratory, so that instruction may begin earlier and a larger number of students may be accommodated, in order that more time may be given to instruction in advanced courses.

4. To secure the above results, more assistance is needed in the physical laboratory; and about $2,000 is needed for additional appliances for elementary instruction.

5. Lastly, I beg leave to call attention to the need of the establishment of some central source of electrical power, a portion of which could be made subservient to the uses of the Department of Physics.

Respectfully submitted.

JOHN LeCONTE,
Professor of Physics.

CHEMISTRY.

To the President of the University of California:

SIR: I herewith present a report of the Department of Chemistry, as requested in your note of the twenty-third ultimo.

The following table will show the attendance in this Department during the last two academic years:

	1886–87.	1887–88.
1. Elementary Chemistry	30	49
2. Inorganic Chemistry	27	27
3. Chemical Philosophy	3	5
4. Organic Chemistry	6	4
5. Qualitative Analysis	30	29
6. Quantitative Analysis	10	9
7. Physiological Chemistry	----------	4
8. Blowpipe Analysis	23	29

Chemistry finds so many important applications and explains so many phenomena of every-day observation that an acquaintance with its rudiments at least should be expected of every educated person. This much is necessary to understand the literature and especially the technical literature of to-day. Every graduate of the University ought to have completed a course in chemistry equivalent to Course I in Elementary Chemistry.

It becomes a question of great importance, whether this work shall be done at the University, or at the preparatory school before coming to the University. There are many reasons, it seems to me, why it should be done at the preparatory school. Every High School will be pretty sure to include this subject in its curriculum; it is needed by those students who do not intend to or who cannot take the University course. A year's time is necessary to do this work well, in a well equipped students' laboratory; and with a systematic course of experimental instruction. It is too much to expect for some years to come that every High School in this State can do the work. The first requisite is capable and trained teachers; where these are to be had the other essentials will soon be found. If the graduates of the University, as they go out into the State as teachers are trained to do this work, they will bring the schools up to this standard. In the meantime it will be necessary to provide this training here at the University and to make it as thorough as possible. I would emphasize the importance of the laboratory training and the necessity of providing suitable accommodations for it. Our present laboratories do not, and cannot well be arranged to do, this work, yet it is to be hoped that when a new chemical laboratory is built, it will contain suitable rooms and conveniences for this work. Students coming from schools where this elementary work in chemistry is done in a satisfactory manner, can be excused from it and allowed to use the time for other studies.*

Attention should be called to the necessity of providing for laboratory work in organic chemistry. While the number of students is not large, it is growing, and the laboratory practice is needed if instruction in this branch is to reach the highest efficiency. The importance of the subject does not need explanation. The great growth of chemical science during the last thirty years has been largely in this field. The great light which it has already thrown upon vegetable and animal physiology and pathology make a thorough acquaintance with it an almost indispensable condition to the intelligent practice of medicine. The new chemical laboratory will contain the necessary accommodations for study and investigation in this branch of chemistry.

In this connection I wish to speak of the importance of a thorough preparation in chemistry to those who intend, after finishing their University course, to study medicine. It is very desirable that such students should complete the courses in Inorganic, Organic, and Physiological Chemistry with laboratory practice. The student who begins his medical studies with this preparation has an advantage which he will keep throughout. Too much emphasis cannot be placed upon the importance of doing this work at the University. The laboratory work is so arranged that it can be adapted to the wants of individual students. A course for those intending to study medicine will be arranged so as to make it of the greatest practical value.

At a meeting of the Academic Senate in 1884, a committee appointed to recommend a course of study preparatory to the study of medicine made a report, which was unanimously adopted. This report placed much stress upon a thorough preparation in chemistry and recommended all students to prepare themselves as well as possible in this subject before entering the Medical College. The object of the committee was to bring about a closer connection between the various departments of the University and to make a closer coöperation possible. The spirit of this report contemplated that young men who had matriculated in the Medical Department could take studies in the Colleges at Berkeley, subject to the approval of the heads of Departments. The Departments specially named were Chemistry, Botany, Zoölogy including Physiology, Physics, Languages, Literature, etc. Advantage has already been taken of this recommendation and a number of good students have received instruction in the courses given at Berkeley. I believe it is desirable to foster this preparatory course to the study of medicine.

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* The students from the Boys' High School, of San Francisco, have a full year's course of chemistry with laboratory practice. Those who take good rank in this subject in this school are excused from Elementary Chemistry (Course 1) at the University. Others passing the examination for advanced standing in chemistry are likewise excused. These students usually employ the time so gained in the prosecution of more advanced work on the subject.

The applications of chemistry are so many and important that great attention should be directed to them. Due regard has been had for this branch, and special attention given in all the chemical instruction to the various applications of the science. We are about ready to announce special courses of lectures upon some of the more important of chemical industries. Mention may be made of the following subjects: explosives, electro-metallurgy or electro-plating, etc. The course of lectures upon Physiological Chemistry is always well attended and is perhaps one of the most important applications of chemistry. It is hoped that this subject can be expanded and that a laboratory course more or less complete can be laid out in connection with it.

It is the intention of the Department to establish a collection of chemical products. Bottles of uniform height and appearance have been ordered in Germany and will soon arrive. When received we will proceed at once to get together as complete a collection as possible. It is believed that great good can be done to the cause of chemical technology in this way. In the construction of the new chemical laboratory due attention should be paid to the claims of technology. Provision should be made for the display of the collection in this branch, and also for the prosecution of investigation of chemical products, etc., for experiments in utilizing wastes, etc.

The necessity for the construction of a new laboratory does not need discussion with any one familiar with the needs of students at Berkeley. The qualitative laboratory is entirely inadequate to the present demands of students. We have been obliged to turn away students who wished to begin chemical analysis. The room was built to accommodate thirty-two students, and we have tried to accommodate thirty-six. The room is not suitable, not well lighted, and poorly ventilated. The evaporating niches are not good, so that it is impossible for the large number of students to work without danger to health. Some relief is absolutely necessary, and it seems as though that could best be attained by providing entirely new quarters for the Department. Due regard could then be paid to the other needs of the Department. Separate rooms are needed for spectroscopic analysis, polarization, volumetric analysis, electrolytic analysis, gas analysis, analysis of potable waters, experiments and investigations in thermochemistry, blowpipe analysis, etc. The modern chemical laboratory should include many small rooms for individual work and investigation, so that, constructed on the most modest plan, a large amount of room will be required.

When the new laboratory is built and equipped, it will be necessary to have the whole time of one man to do the janitor work. Such a man could, in time, learn to render much valuable service in the preparations of many reagent substances for the collection, etc., in addition to his janitor work.

The appointment of two student assistants has relieved the Department very much. This does much towards restoring the original number of assistants in the Department.

The appropriation of $2,400 per annum will enable us to keep up the supply of apparatus and chemicals in a fairly satisfactory manner. We cannot get with this amount expensive and showy pieces of apparatus, but can keep up the supply of ordinary material.

I add a sketch of the work in my Department:

Schedule of Work of the Department of Chemistry.

- Instruction
  - Elementary Principles
    - Class and Laboratory.
  - Advanced
    - General
      - Organic.
      - Inorganic.
    - Theoretical (Chemical Philosophy).
  - Applied
    - Chemical Technology.
    - Physiological Chemistry.
  - Analysis
    - Qualitative.
    - Quantitative.
  - Synthesis
    - Inorganic.
    - Organic.
- Investigation
  - Scientific
    - New reactions.
    - New compounds.
    - Reëxamination of Constants.
    - Improvements in Analyses, etc.
  - Industrial
    - Analysis of
      - Minerals.
      - Mineral Waters.
      - Plants and Plant Products.
    - Experiments in Utilization of waste products. Establishment of Collections in Chemical Technology, etc.
- Direct and Practical work for the State (Office of State Analyst)
  - Detection of adulterations in food, drugs, wines.
  - Examination of Medicinal Plants.
  - Analyses of Mineral Waters, etc.

Respectfully submitted.

W. B. RISING,
Professor of Chemistry.

ZOOLOGY AND GEOLOGY.

To the President of the University of California:

SIR: The course of instruction in my Department has undergone no material change in the last two years; but the materials for teaching and for investigation have been increased very considerably.

1. By the addition of a large series of *Auzoux models,* illustrating anatomy and physiology, both human and comparative.

2. By a series of large wall models, illustrating the structure of the most interesting geological fields in our own country and in foreign countries, and admirably adapted to the teaching of structural geology.

3. By a full collection of fossils, representing the whole geological history of the earth, and mostly from American rocks. This collection has already proved of great importance in illustrating the general course in geology, and will be of still more importance as a basis of special study in palæontology. In this collection there is a series of sub-carboniferous crinoids, which is probably unsurpassed in any museum.

WANTS

The great want of my Department, and as I am convinced, also of the University, is a separate chair of Biology and a biological laboratory. To my department such a chair is important as a preparation for effective teaching, both in zoology and geology. To the University it is important: (*a*) on account of the great importance of the *subject-matter* in a course of general culture; (*b*) as an admirable example of training in modern laboratory methods; (*c*) as a necessary preparation for the study of medicine, and (*d*) as a school for the training of teachers in this department for our public schools. I am also quite certain that many students are looking forward with anxiety to the establishing of such a chair, and that classes in this Department would be immediately quite large.

Respectfully submitted.

JOSEPH LeCONTE,
Professor of Geology and Natural History.

MINERALOGY.

To the President of the University of California:

SIR: The general resources of my Department are in fair condition, and are being well, although not fully, utilized. I have to make some suggestions for improvement in this respect. Since the transmission of the last Biennial Report of the President of the University various changes and additions, materially strengthening the teaching effectiveness of the Department, have been made. The gas engine and electric motor furnish ample power for the cutting and grinding of mineral and rock sections; the electric lantern microscope, while not yet in good working order, will soon be made so. It has already been amply demonstrated that for effectiveness of lecture illustration in mineralogy and petrography, it is beyond all comparison superior to the former method, with a number of table microscopes. I have obtained also a series of *large*, thin rock sections (3 in. by 4 in. in area), which, projected upon the screen with an ordinary sciopticon, give a definiteness of conception of rock-textures that cannot be obtained from the hand-specimens alone. I cannot speak too highly of these methods of lecture illustration. A totally new world was opened to us when the microscope was applied to the study of rocks, and to present this new world with every detail of form and color to a class of students while the necessary explanations are being made, is a gratification that could not have been anticipated a few years ago.

Rapid progress has been made during the past two years in the preliminary determination of the rocks collected by the State Geological Survey under Professor Whitney, but much still remains to be done. As fast as determined, these rocks have been incorporated in the museum. From this source, and by purchase in the Eastern States and in Europe, the growth of the Petrographical Museum has been very great, both in size and particularly in scientific value. Nearly every rock-specimen is accompanied by a corresponding thin section for microscopical study. The collection of thin sections now numbers nearly two thousand five hundred.

Additions have been made but very slowly to the Museum of Economic Geology, inasmuch as material available for the collection can be obtained only from exceptionally intelligent men, and from them only by donation. Twenty-three mines have been added to the collection since the last report. The collection cannot be said to be in a fit condition to form the basis of a course of instruction in economic geology. There is no representation from a single ore, coal, or other deposit of economic value east of the Rocky Mountains or in Europe. This great lack can be appreciated only when one remembers that the whole literature of economic geology is founded almost exclusively upon investigations conducted elsewhere than on the Pacific Coast.

The policy of furnishing information of general interest concerning material sent to the museums under my charge, in return for the specimens, has been continued and has been productive of extensive additions to the collections. This has, in fact, always been the main source of growth, and while it imposes much work and correspondence, the compensation in the growth of the collections has been more than an equivalent.

During the past two years some investigations of the building stones of the State have been made. Circulars were sent to quarrymen and others supposed to be interested, stating the character and objects of the examinations to be made, and requesting a supply of the necessary material. The returns have been so meager that much less has been accomplished than had been hoped. The State Mining Bureau generously contributed towards the expense of the investigations, and the results have been published in the State Mineralogist's reports and in bulletins from the University. This work will be continued as the material becomes available.

I desire to suggest certain changes in my courses of instruction, with the view of making them accessible to a larger number of students. It has always been desirable that students in the Colleges of Mining, Civil Engineering, and Agriculture should obtain some instruction in petrography before leaving the University. At the present time, the petrographical course requires a one-term course of two hours per week in polarized light as a prerequisite, and continues itself through two terms at the same rate of two hours per week. In the crowded state of the curricula it has been possible for but very few students to find the time necessary for so extended a course. I propose hereafter to divide the present course into two independent courses. The first will continue through one term at the rate of two hours per week, and will cover texture, structure, forms of rock masses, decompositions, genesis, and descriptive petrography, illustrated by hand-specimens and thin sections on the screen. For this course the Junior year course in mineralogy will be the only prerequisite. It will be followed in the second term by a very short course in macroscopic laboratory practice. The second course in petrography will be devoted entirely to micropetrographical laboratory work, at the rate of two schedule hours (six laboratory hours) per week for one term, and for this course the course in polarized light will be a prerequisite. All the students in the above mentioned colleges will find it possible to take the first course in petrography, and will obtain an amount and a kind of training such as *all* should have, while such as desire to become expert petrographers may then continue through the micropetrographical laboratory course.

NEEDS OF THE DEPARTMENT.

I have at present one student assistant, at $240 per annum. This compensation gives me, ordinarily, the spare time (twenty to twenty-four hours per week) of an undergraduate, who is qualified to do little more than the manual labor connected with the grinding of thin sections, and the general work of the Department. By accident, I am enabled for the current year to avail myself of the assistance of a competent chemist, who has been through my own courses of instruction, and who can thus be of real assistance in the work upon the minerals and rocks of the collections. I need the *entire*, instead of the *spare*, time of such an assistant, and this cannot be obtained for less than $600 a year.

Large as is the mineralogical collection, literally hundreds of mineral species, and many of these of economic value, are not represented in it. The cause of this state of things is the manner in which the collection was formed, viz.: exclusively by donation from friends of the University. With the exception of about one hundred minerals, purchased by Professor Fisher before 1870, no money has ever been expended by the University upon the collection. One thousand dollars could wisely be used in filling out the gaps of the collection, materially increasing its teaching effectiveness.

Till within the past two years the foregoing has been equally true of the petrographical collection. It consisted practically of the undetermined local collections of the State Geological Survey under Professor Whitney. Something over one thousand rocks from the Eastern United States and from Europe have recently been added, obtained by purchase with funds from the last legislative appropriation. A time limit for the making of these foreign collections was set, on account of the lapsing into the general State treasury of all special appropriations unexpended on a certain date. Notwithstanding the unanimous complaint of all from whom the collections were purchased, that it takes *time* as well as *money* to make large collections, all shipments had to stop when the date of limitation arrived. To complete this collection of rock-types, $1,000 should be set aside with no time limit short of three or four years for its expenditure.

With respect to the Museum of Economic Geology, I can only quote the statement contained in the last Report of your predecessor. The situation remains unchanged. It is even more imperative that no time limit should be set for the expenditure of funds set aside for the collection, on account of the great difficulties of obtaining the material.

The Museum of Economic Geology, which should contain a suite of specimens illustrating the mineralogical composition, wall-rocks, and geological peculiarities of every important mine in the United States, and of the leading mines of Europe, has been hardly more than projected. It contains collections from a few California mines, obtained personally by the Professor in charge, and from a few other mines, donated by the friends of the institution. The collection is one of the most important, both from educational and scientific points of view, that the University should make, and at least $5,000 should be appropriated for obtaining by purchase the material that cannot be personally collected by the Professor.

Such a collection would find its most important use in immediate connection with the instruction of our Mining students in the special branch of Mining Geology.

One section of the Museum of Economic Geology is of especial interest to students in Civil Engineering, viz.: that containing the building stones, artificial stones, clays, mortars, cements, bricks, mineral paints, etc. A nucleus of local material is being gathered by Whittier, Fuller & Co., Gladding, McBean & Co., F. Clarke & Son, and E. L. Ransome, of San Francisco. This material should be supplemented by purchase in the East and in Europe. It is difficult to estimate the cost of such material, as much of it may be obtained by donation, or by defraying the cost of freight. I would suggest that $500 be made available for this purpose.

I have on every proper occasion called attention to the need of a crystal model collection. Were it not for the courtesy of Professor Rising, who has loaned me his private collection of models, and a small private collection of my own, my Department would be practically without this indispensable adjunct to the teaching of mineralogy and crystallography. As it is, these few models are totally inadequate. A complete collection of crystal models fit for lecture illustration would cost $615.

Miscellaneous physical and chemical apparatus, and material for the illustration of crystallographic optical reactions, costing in all about $500, are needed.

Finally, for the current expenses of laboratory work, exchange of specimens, etc., $50 per month should be available.

I shall say nothing here of the need of fit museum room for the collections under my charge, further than to express the hope that the removal of the Chemical Department from the South Hall into a building of its own will make possible the use for the museums of my Department of the room now used as a chemical lecture-room.

Respectfully submitted.

A. WENDELL JACKSON,
Professor of Mineralogy, Petrography, and Economic Geology.

TECHNICAL SCIENCE.

Agriculture, Viticulture, Entomology, and Botany.

To the President of the University of California:

Sir: In response to your request I transmit herewith a general statement of the operations of the Department under my charge, for the years 1887 and 1888. It was my intention to have had not only such a statement, but the full record of the experimental work accomplished since the date of the last report, in print before this time. But the period of relative leisure usually following the high pressure of the vintage season, has, during the early part of the current year, been more than fully occupied by the extraordinary duties imposed upon me by the appointment to the directorship of the Experiment Stations to be established under the "Hatch Act," and the necessity of providing for the proper expenditure of the appropriation, made by Congress in February, before the expiration of the financial year on July first. As even the University vacation has been covered by the same work, it has been impossible to put all of the voluminous material on hand in shape for publication; and even the usual issue of frequent bulletins has, from the same cause, been almost suspended. As a matter of special interest for the present vintage, however, I elaborated and put through the press during the vacation a special report on the results of the comparative fermentations made during the preceding season.* This document, which has already been extensively circulated, you will please consider as a part of the present partial report.

INSTRUCTION.

While there has been no change in the *personnel* engaged in instruction in this Department, and while during the first session covered by this report there was no material change either as regards the means for instruction or the attendance of students, a very marked change in both of the latter respects has occurred within the present year, in consequence of the erection of the new Experiment Station building, and its being fitted out with the proper appliances for convenient and effective work. Up to that time the Department had no definite location, its rooms and laboratories being scattered in various parts of two buildings, one of which was the reverse of creditable both in outside appearance and inside appliances, although much good work has been done in it. The depressing effect exerted upon the Department by this state of things has become apparent now that its various branches are conveniently and decently located in one building, adapted to its purposes, and having some room for future expansion. Not only are the lecture classes from two to three times larger than they have been since the Department has ceased to afford a convenient place of refuge for indolent students, but the desk room provided for laboratory students on the basis of the estimated increase for two or three years has been at once taken up by active workers, to the embarrassment of the experimental work for the time being, as no corresponding provision had been made for such increase, in the corps of assistants. The two or three students we have had heretofore have generally become of material assistance in the work after a short time, and added little to the assistants' duties; but if the experience of the present session is to be repeated, and perhaps on an enlarged scale, special provision for instruction will have to be made, and additional desk room will have to be provided.

The students attending the lectures on Agricultural Chemistry and the course in Vinification and Wine Analysis, as well as the laboratories, are really of two distinct classes; namely, advanced students from other courses, already proficient in general chemistry and desiring to specialize in the direction of agricultural work; and new students who have little theoretical knowledge, but are more or less proficient in practice, and desire to obtain for that practice a correct basis, and especially the ability to perform chemical and microscopic analyses. It is not easy to combine in one course instruction suitable for both these very diverse classes. Each student really needs to have a special course laid out for his particular case, and must currently receive personal attention, the more so as no text-book is available for such work. In many cases it becomes absolutely necessary for those entering to receive private tutoring or "coaching" in order to enable them to follow the course with profit. Despite all these difficulties, I think these courses constitute a very useful and attractive group of studies, and supply a rapidly growing demand for professional instruction, precisely such as is contemplated by the "Morrill Act" of endowment. So long as no diploma is asked for by those pursuing such studies, no lowering of the University's standard of proficiency can occur in consequence. But it is absolutely essential that an adequate force of competent assistants be employed, so as not to encroach upon the work of the Experiment Station. With this condition, I consider that both kinds of work are benefited by the proximity and interconnection; for nothing so enhances the interest taken by a student in his work as the feeling that he is doing something new that will stand to his credit on the record. No such zest is created by the perfunctory pursuit of a predetermined set of operations. The habit of original, critical, and logical observation is invaluable in a field like agriculture, where the conditions surrounding every phenomenon are so exceedingly complex, and where hasty and illogical conclusions are so common, and so costly in their consequences.

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* Reports of experiments on methods of fermentation and related subjects during the years 1886–87. Advance sheets from the annual report for 1888.

The lecture course in Agricultural Chemistry, the time for which has always proved somewhat too short for the desirable completeness, on account of the absence of an appropriate reference book for self-study, can now be more satisfactorily arranged by the use of the excellent work "Agriculture," lately published by Professor F. H. Storer. It supplements most acceptably both the theoretical and practical courses in agriculture, and is strongly recommended for study both to students and practical farmers.

The want of a book of corresponding character, in the English language, in the matter of viticulture and vinification, is a constant drawback in the instruction of those not possessing a reading power of the German or French languages. I have long had in contemplation the filling of this gap, and embodying the results of the work done at this station with a special view to the needs of California; but lack of the needful leisure has thus far prevented my doing so, nor do I see any present prospect of being sufficiently relieved from extra duty for the performance of this task, which would save a great deal of work in the way of answering letters of inquiry on elementary subjects connected with viticulture, and would prove useful in many other ways to the viticultural industry of the State.

The course in Practical Agriculture, which includes breeding and care of live stock, feeding for various purposes, dairy practice, growth of cereals and other field crops, etc., has been regularly given by Mr. Wickson. The attendance of regular students has, as usual, been small; but there has been an increasing interest on the part of outside persons, who are ranked as "visitors" in the University classification. These have included both young and old, who have recently come to the State and have applied for entrance to the lecture-room for the purpose of informing themselves in a general way concerning California conditions and practices before enlisting in agricultural pursuits here. Especial attention is paid to the wants of this class of applicants, and instruction has been shaped somewhat to meet their expressed needs. The same is true of the course in Practical Horticulture, which includes not only general reviews of fruit growing from industrial points of view, but consists largely of actual field instruction in the propagation of fruit trees from seed, bud, or graft, and their after-care and culture by pruning, tillage, fertilization, etc. This course has proved attractive, as might be expected in a State where the fruit interest is as prominent and promising as in California. It is Mr. Wickson's desire to render this course as popular and useful as possible, and he takes every opportunity—by attendance upon fruit growers' meetings, horticultural fairs, and by visitation of orchards, etc.—to keep himself abreast of the progress which is being made in the horticultural art in California. It is planned to secure, whenever the available funds will permit, specimens of fruit true to name, which will serve as material for a more scientific study of California fruit varieties, and afterwards, either in wax model or in preserving fluid, be a means of popular identification of the many varieties which are being grown under incorrect local names. It is also proposed to include the scores of California seedling varieties, which are coming into prominence and in many cases prove superior, locally, to the old standard varieties. Such a collection, exhibited together with various local inventions in the form of tools, smaller implements and handy contrivances, would constitute a horticultural museum which would be of great value as an adjunct in regular instruction, as a means of education in California materials and practices, of much interest and service to new-comers; it would serve also to popularize the work of the institution. Such a collection would require but a moderate expenditure. The greatest item will be the time required for the effort, and that, it is hoped, can be commanded.

The instruction in Elementary and Economic Entomology has been continued by Mr. Wickson as in former years. As has been noted in previous reports, this work is done by him as a volunteer instructor, and he is willing to continue it until so important a subject is better provided for on the University staff. Mr. Wickson makes no pretensions as a professional entomologist, but he has for a number of years followed the subject as an amateur and has gained a fair acquaintance with California insect pests, their identification, life-history, and the means most successful in checking their increase. His work, therefore, answers immediate needs fairly, but, as I have repeatedly urged in previous reports, there is imperative demand for a thoroughly trained entomologist, who shall act as a Professor of Entomology in the University and as a State Entomologist in the service of the public at large. The demand upon the University for this class of work becomes the more direct because the study of entomology is now prescribed in the public schools, and teachers are required to fit themselves for examination in this subject when applying for certificates. This consideration is perhaps more forcible in connection with University equipment than is the popular demand for advice and information concerning the myriad pests which are undermining our agricultural industries; but both branches of the work can fortunately be met by the same officer, and thus the suggestion becomes doubly strong.

In the meantime Mr. Wickson has been conducting his growing classes in entomology to the best of his ability, and the correspondence with those who send insects for determination and ask for remedies, occupies much of his time. In the fitting-up of the lecture-room on the second floor of the Experiment Station building, a table has been extended along the north side of the room which receives the light from four large windows and gives the class the illumination most desirable for entomological and especially for microscopic work. This table is fitted with drawers for each student to keep his outfit of appliances, and with shelves above for the larger appliances and for bottled specimens. Two breeding cages, after the pattern of Professor Riley, United States Entomologist, have been secured, and three small compound microscopes have been purchased for the use of students. The foregoing, with the Ricksecker collection of Coleoptera which was donated several years ago, constitute the entomological outfit of the department. It is exceedingly meager considering the character and popularity of the work, but it is made the best of in class instruction. Mr. Wickson's private microscopical outfit and collection of entomological books and reports are also in constant use.

Field and orchard experimentation has likewise formed a part of the work in entomology. The experiments with the codlin moth, which were reported to the Fruit Growers' Convention of 1887, and issued in the reports of the State Board of Horticulture and in the University bulletins, have attracted wide attention, both in this State and at the East. Similar treatment has been accorded to the report of experiments with grains resisting the attacks of the Hessian fly.

THE EXPERIMENT STATION WORK.

General Statements.—During the year 1887 the Experiment Station work was carried on in the usual manner, as to kind and amount, as will appear from the detailed record now in preparation, but which, as before stated, could not be published in 1888 on account of the engrossing of my entire available time in the establishment of the new stations under the "Hatch Act." A special feature of that season's work, in the agricultural laboratory, was the experimental investigation of the effects of various insecticide gases upon citrus trees infested with that terrible pest, the *Icerya*, or "cottony cushion scale," which has rendered the culture of these fruits unprofitable in the infested region, and threatens that important industry with total extinction wherever it has been allowed to spread unchecked. This investigation, which resulted in the complete demonstration of the efficacy of hydrocyanic gas when used under proper precautions, within a reasonably gas-tight envelope or tent, occupied during several months the time of Assistant F. W. Morse, whose ingeniously devised apparatus for generating the insecticide gas in the proper manner has been in use, with little change, ever since. The results of his work were published in bulletin form at the time.

During 1888 there has been an unusually heavy demand for the analysis of waters of all kinds, as well as for examinations of "alkali" soils, and, as a result, the regular progress of the leading work—the examination and classification of the soils of the State—fell so far behind even the current demand, that I requested and obtained the appointment of a special assistant to aid in bringing up the delayed work to date—for four months from March first. Mr. Adolph H. Weber filled this position very satisfactorily during that time, and, at my request, was reappointed from September 1, 1888, until the end of the session, as it would otherwise be again impossible to prepare the reports (which will now have to cover the work of two seasons) for publication.

The following is a list of the bulletins issued since the last annual report was made. The issue of only four of these during the year 1888 was in consequence of the unusual pressure of work, as stated above.

LIST OF BULLETINS

Published since Issuance of Last Report.

Current Number.	Title or Subject.	Date of Issue.
61	Distribution of Seeds and Plants	December 23, 1886.
62	Distribution of Cuttings and Scions	December 29, 1886.
63	Experiments on Methods of Fermentation	January 6, 1887.
64	Planting and Grafting Resistant Vines	January 28, 1887.
65	Shall California Make Sophisticated Wines	February 11, 1887.
66	Principles and Practice of Pasteurizing	February 25, 1887.
67	Misconception of the University Viticultural Work	March 26, 1887.
68	University Distribution of Seeds, Plants, etc. Influence of the Mode of Fermentation on Color of Wine	April 15, 1887.
69	Wine Colors and Color Wines	May 12, 1887.
70	Abnormal Deposits on Vine Leaves Mysterious Death of Vines; Remedy for Anthracnose	June 4, 1887.
71	Uses of Gases Against Scale Insects	June 12, 1887.
72	Sugar Beets at Fresno. Hessian Fly and Resistant Grains	August 12, 1887.
73	Use of Hydrocyanic Acid against Scale Insects	August 27, 1887.
74	Vintage Work and Instruction in Vit. Laboratory in 1887	August 26, 1887.
75	Spray and Band Treatments for the Codlin Moth Difficult Fermentations	November 19, 1887.
76	Distribution of Seeds and Plants	December 10, 1887.
77	Extraction of Color and Tannin during Red Wine Fermentation	December 30, 1887.
78	Report on the Establishment of Outlying Stations	March 12, 1888.
79	Experiments with Hydrocyanic Acid, etc.	May 5, 1888.
80	Progress of Experiment Station Work	August 29, 1888.
81	Distribution of Seeds and Plants	December 10, 1888.

The operations of the station during 1888 have been materially modified by the working of the "Hatch Experiment Station Act," which was passed in June, 1887, but owing to inaccurate wording did not become effective until, in January, 1888, a supplementary appropriation act was passed by Congress. Owing to various official delays, however, definite action looking toward the expenditure of the appropriation for the fiscal year 1887–88 could not be taken until about the middle of March, 1888, thus allowing only three and a half months' time within which to consummate the expenditure according to the terms of the law, of the total appropriation of $15,000.

As the experimental work done heretofore was precisely of the general character contemplated by the Hatch Act, that appropriation might lawfully have been applied wholly to the expenses of that work, that within the last years had very nearly come up to that sum. But it had been tacitly understood for some time past, that in accordance with my former recommendations and with the expressed desire of the State Grange and other agricultural societies, the establishment of outlying culture stations should be the next step taken when funds become available. At a meeting of the Board of Regents, held March 13, 1888, I was appointed Director of the University Experiment Stations, and was directed to take immediate steps toward the consummation of that object, in conformity with suggestions previously made by me in a communication addressed to the President of the University. The text of this communication, which was published as "Bulletin No. 78," and outlines in brief the plans that have been pursued since, will best serve to explain them, and will be introduced later.

The cultural work of the central station at Berkeley has, as heretofore, been carried on, under the direction of Mr. Wickson, by Mr. K. McLennan. Here, also, the advantages of a more liberal supply of funds have become quickly apparent in more satisfactory work, both in quantity and quality, and in the accomplishment of some improvements and repairs long needed, but deferred for want of means until patching-up had become impossible. Some of the additions and changes made are given below under separate heads, in accordance with reports received from Mr. Wickson. There remains one capital change, or rather addition, yet to be made. I allude to the need of a sufficiently large conservatory, commensurate with the needs and rank of this institution. The old propagating houses can scarcely rank as even an approach to a proper conservatory or plant house, being hardly more than sufficient for the actual demands of the propagation of stock for distribution; a demand which it is easy to foresee will last for some time to come, as new districts are settled and new culture plants come forward. Were it not that our mild climate permits of the growth of so great a variety of plants out of doors, the inadequacy of the collection we can maintain inside of the present houses would have been still more painfully felt. Unless a proper plant house can be obtained through private munificence—a hope long but vainly entertained—one of the most pressing needs of the central station will be the provision for such a building from the funds that may be so applicable. It is especially important for the purposes of the Department of Botany, which, under the able hands of Assistant Professor E. L. Greene, and with the room for collections and work now afforded by the space vacated through the transfer of the agricultural laboratory and lecture-room to the new building, will be sure to increase greatly in efficiency and popularity. A special allowance of funds to the Department of Botany for museum appliances and work is urgently needed.

The following details regarding the condition of, and work on, the experimental grounds at Berkeley are supplied by Mr. Wickson, whose efficient and judicious management of the departments committed to his care, and general helpfulness wherever help is needed, require special acknowledgment on my part.

CULTURAL EXPERIMENTAL WORK AT THE CENTRAL STATION, BERKELEY.

Greenhouses and Nursery.—During the last year the greenhouse has received many long-needed repairs and refittings. The old home-made heating apparatus, which has been notably ineffective for several years, has been replaced by a Harvey hot-water boiler, with a system of three-inch pipes; and the new system has been made to heat much more house-room than the old. This extension was imperative, not only for rendering plants safe in the lower house, but to afford more space for the propagation of plants which are demanded by the increase in the distribution. The houses have also been improved by the replacement of parts which were falling into decay, and thus the outfit, though notably scanty and totally inadequate to the completeness and display which is naturally expected from a public institution, is now in condition to meet present actual needs; but in the existing progress of affairs it cannot be expected to answer the purpose long.

With the removal of the ornamental and forest trees from the nursery to the arboretum, space became available for the propagation of part of the fruit trees which will be needed for planting at the outlying culture experiment stations of the University. The buds set the past summer have taken well. The nursery ground has also been used in part for growth of tree seedlings for the coming year's distribution.

The Garden of Economic Plants.—During the last two years the care and culture of the Garden of Economic Plants has been much the same as in previous years, and the garden has fairly answered the expectations entertained for it. There has been a complete renewal of the labels, and this feature is now in quite satisfactory condition; except that some additions and revisions, from a botanical point of view, must be made as soon as time allows. The garden serves a good purpose in furnishing materials for illustration and study for the classes in botany, and its acceptability to the public is seen in the numbers of visitors who carefully study the trees and plants. The collections, consisting largely of forage plants and garden vegetables, have been considerably increased, seeds having been secured both by purchase and donation, from native and foreign sources. The seed product of the garden plots forms a large part of the material annually distributed for trial by voluntary experimenters in all parts of the State, as will be specially mentioned under the proper heading. Whenever possible, material is supplied to inventors of new industrial machines and processes, the *Ramee* plots having been in special request by such persons.

The cold wave of January, 1888, wrought considerable havoc with plants which had survived the more moderate visitations of previous years. A loss which is much regretted was inflicted in the killing of the collections of cinchonas, even though the plants were protected by a thatch. Only one of the several varieties has shown any disposition to start again from the root, and even that gives but little promise of healthy revival. This loss is the more regretted because one of the little trees was coming into bloom, and hopes were cherished of securing some locally grown seed, from which possibly hardier seedlings could be propagated. The season at which the bloom appears here (in December) makes it doubtful whether the flowers would survive even the ordinary January cold of this locality. The interesting notes which were obtained of the effect of the low temperature (+24°) upon various plants on the University grounds suggested a collection of frost effects from our correspondents in various parts of the State, and these observations will be compiled for our forthcoming annual report.

The University Orchard.—During the last year the condition of the standard orchard has been materially improved by the construction of a comprehensive system of under-drainage. In previous reports this work was urged, but funds were not available for it until the last year. The situation is now well fitted to give as satisfactory results in growth and fruitage of trees as such a naturally poor piece of land can give. With its even slopes to west and southwest, it lies well for drainage; the main difficulty was in excavation. For to get the average depth of three and one half feet, considerable broken rock had to be dug out, and occasionally material as tenacious as pipe clay had to be removed. Such things are not good marks of orchard ground, and the improvement which will undoubtedly follow the introduction of under-drainage will serve well to illustrate the advantage of such a treatment of poor ground, and thus prove of considerable practical value. In the construction of the main drains three-inch tile was used; the laterals being two-inch tile. About one thousand five hundred feet of the former and three thousand feet of the latter were used, with the necessary connections. The small stone thrown out of the trenches and picked from the surface were used to bed and cover the tile, and the work has been done as well as possible to secure the quick removal of surplus water and the permanent efficiency of the drains.

Records and observations on the fruit varieties as they ripened have been made as heretofore. Increased use has been made of the collection as a means of determining doubtful sorts, and, as will be noted under the head of distribution of seeds and scions, a vast number of cuttings for budding and grafting have been sent out to applicants from all parts of the State. The fruit has also been exhibited at the State and Mechanics' Institúte Fairs, and the attention of growers has been thus drawn to several desirable and little known kinds.

The Arboretum.—Sympathizing with our desire for opportunity to establish an arboretum on a more comprehensive scale than the grounds of the College of Agriculture permitted, the Secretary of the Board of Regents kindly set apart for our use a portion of the hill lands of the University which has previously been used for pasturage, and the Regents sanctioned the expenditure necessary to bring the areas into condition for planting and making them accessible.

Thus, in addition to the tree growths on the west portions of the University domain, we have now three tracts planted with timber and ornamental trees, at different elevations on the hillsides which comprise the eastern part of the grounds. The highest is near the summit of the first ridge, about nine hundred feet above tide water. It was first planted with English oaks, but as these proved very toothsome to the ground squirrels, there were a number of vacant spaces at the end of the first season. The missing oaks were replaced with cork oaks, cork elms, camphors and species of pine, cypress and acacia. At present the upper plot is, therefore, a very promising plantation, including a number of kinds of trees; and the future growth will furnish data for interesting conclusions as to the ability of the varieties to shift for themselves on an arid hilltop. Considering the unusually dry character of the last two years, the present condition of the plantation must be considered quite satisfactory.

The second planting was made in the winter of 1887, and consisted of an irregular piece of ground at the southwest base of the same ridge, where the soil is deeper and naturally more moist. This piece was laid out with winding walks, and aside from the lessons to be obtained from the success or failure of the plantings, the plot will serve as a very acceptable addition to the campus of the University when the upper part of the grounds shall be improved. On this piece a number of ornamental shrubs were introduced, placing them adjacent to the walks and in front of the taller growths.

The third parcel of ground, which was prepared and planted during the winter of 1888, consists of a sloping bench on the east base of the ridge first mentioned, and at the mouth of what is known as Strawberry Cañon. Its general slope is toward the southwest, and it commands an extensive view across the Oakland plain, with the city of Alameda and the lower arm of San Francisco Bay beyond. A road was cut from the second plot to the third; on the latter there was considerable grading done, and then the area laid off with winding walks in such a way as to admit of their extension upon the more accessible parts of the adjacent hillside, for the case that it should be considered desirable to advance plantations in that direction in the future. This plot was planted with groups of trees and shrubs somewhat according to natural affiliation, and includes species from nearly all parts of the world.

It will not be possible to specify further, in this place, concerning these forestry experiments, of which it is intended to give a more detailed account in the next Annual Report of the College of Agriculture. Enough has been said to indicate the interest taken in this important branch of experimental work, and that the University, both by its local experimentation and by distribution of forest seeds and seedlings, is doing its share in furtherance of the honorable and valuable efforts of the tree planters of the State.

Distribution of Plants, Seeds and Scions.—During the last two years this work has reached an extent far beyond previous records. About six hundred applications have been received and upwards of three thousand packages of trees, seeds, or scions have been sent out each year, or an average of about five different articles to each applicant. The detailed description of this branch of the work naturally belongs to the Annual Report. It may be remarked, however, that the disposition of those receiving these seeds, plants, etc., is to give them careful trial and to report results. A vast correspondence comprising reports of local experiments in nearly all parts of the State, is now awaiting compilation and tabulation for the Annual Report.

THE OUTLYING CULTURE STATIONS.

[The outlying stations for experimental cultures of all kinds, that have been established during the current year, are still in an inchoate condition; and it therefore seems best to give in this place, at present, only such matter as relates to their establishment and preliminary equipment, without entering into the details of their location and of the region they represent.]

BULLETIN No. 78.

REPORT ON THE ESTABLISHMENT OF OUTLYING STATIONS.

(Made March 12, 1888.)

President E. S. HOLDEN:

DEAR SIR: I respectfully submit the following considerations and statements concerning the organization of the Agricultural Experiment Station work under the provisions of the "Hatch Bill," which has now been made effective by the appropriation that has lately passed Congress:

The Experiment Station work that for ten years past has been carried on so far as the funds of the University, and the State appropriations made from time to time, have permitted, is entirely of the character contemplated by the "Hatch Experiment Station Bill," and the interest it has excited in this State has not only found expression in the increased appropriations consecutively made for its support by the Legislature, but also by the desire manifested for its expansion so as to provide adequately for the varied needs of the widely different climatic regions of California. It being manifestly impossible to represent by the work of any single station the conditions of a State coextensive with the section of the Atlantic Coast reaching from Cape Cod to the Savannah River, the establishment of *outlying Culture Experiment Stations* has long been urged, and to some extent the demand has been supplied by the annual distribution of seeds and living plants throughout the State, to persons applying for them and willing to make trials and report thereon to the Agricultural Department. The last annual report records the outcome of a large number of experiments thus initiated; yet it cannot be denied that, considering the large number of persons to whom distributions have been made, the responses have been relatively few, and too often of a very unsatisfactory character, owing to the unavoidable want of necessary attention on the part of the distributee. At all events, these results have served to emphasize the need of Regional Culture Stations under competent supervision, and the desire of the agricultural public in that direction has repeatedly found utterance in resolutions of the State Grange, State Conventions, and other public meetings. Those passed at the last meetings of these bodies are especially emphatic, and the support thus given has doubtless aided greatly in the passage of the appropriation Act through Congress.

Our general policy in regard to this subject being thus understood, the principles that should guide in the establishment of such culture experiment stations require a brief discussion.

In determining the proper location of the outlying stations, their distinctive objects, and relation to the central station at Berkeley, should be kept clearly in view. The latter must of necessity cover the *whole* ground of investigation in agricultural science and practice, as recited in the Act of Congress, and as heretofore carried out so far as the means at command permitted. The outlying stations, on the contrary, are designed to be essentially "culture stations" only, in which the adaptations of culture plants to the local climates and soils are to be tested systematically, in order to relieve the practical farmer from the necessity of making such trials at his individual and often very heavy expense in unproductive investments, and the results of which, after all, are not convincing to others, and do not become part of public experience.

With this object in view it is evident that in the selection of locations for such stations the following points should be primarily regarded:

1. Each station should be representative of as large an area of agricultural land as possible, with respect to climatic conditions, first of all; and, secondly, with respect to soil conditions.

2. Agricultural regions of which the adaptations and peculiarities are still uncertain, should receive attention first, since it is here that the greatest volume of work remains to be done; while in regions that have been settled up long ago, the trials of individual culture plants that may come into question may be intrusted to intelligent individuals.

This implies, conversely, that when, after a time which may vary from ten to twenty or more years, a culture station shall have fulfilled its main objects, it may be dispensed with or transferred to another locality standing in need of such work. Yet it may also turn out to be desirable to maintain some outlying station or stations permanently, and invest them with additional functions in the prosecution of agricultural experimentation. Under this point of view it would seem to be desirable that the lands occupied should be held in trust, or on lease, rather than in fee simple, by the University.

It is my impression that such tenure of land for the purposes of a culture station can, in most, if not in all cases, be obtained by consent or donation from the owner, with only nominal expense to the institution.

As regards the necessary buildings, the Act provides that a sum not exceeding $3,000 may be expended for buildings and repairs the first (this) year, but thereafter only $750 per year shall be so applicable. This provision was evidently intended to prevent the improper use of the fund for extensive buildings, allowing only what is considered absolutely essential, such as dwellings for employés, barn, tool and propagating house, to be defrayed out of the appropriation. This works well enough where, as in the smaller Eastern States, one single station answers all purposes, But where, as in California, at least five stations (besides the central one at Berkeley) will be required to represent even remotely the several agricultural regions, this provision leaves us without the means of providing for their buildings.

From the offers and suggestions already received, I believe that this difficulty can be overcome by inviting subscriptions to defray the cost of needed buildings in the localities or regions that will be benefited by their establishment. It would manifestly be invidious to allot the whole $3,000 permitted by law to any one favored locality, unless it be the central station at Berkeley. The latter, as you are aware, stands in the most urgent need of buildings that shall properly subserve the uses of the Experiment Station, which at present has neither office, nor collection room, nor adequate laboratory accommodations. In conformity with this view, I have already submitted to you suggestions and plans by which, supplementing the $3,000 with an appropriate sum from the University fund, a satisfactory building for the use of the station may be constructed, mostly upon foundations already existing. This is really the first need for the successful management of the already complex work, which will become additionally heavy and complicated when the outlying stations shall have been established.

As regards the number and general collocation of these culture stations, I have already, in former reports and communications, outlined my views in the premises. They are based upon the natural agricultural subdivisions of the State, which may be stated as follows:

1. Southern region, from San Diego to Santa Barbara, and inland to the Mojave and Colorado deserts.
2. San Joaquin Valley, from the Tejon Mountains to Stockton.
3. Sacramento Valley, from Stockton northward.
4. Foothills of the Sierra, substantially from Fresno to Tehama County.
5. Coast Range region.

It is impossible to make fewer divisions, and, consequently, *five outlying culture stations* is the minimum number that can at all represent the State. The Coast Range might be supposed to be represented by the central station at Berkeley, but it is notorious that this is not at all the case. The Berkeley climate represents only a very limited area, directly influenced by the fogs that pour in through the Golden Gate at the time when the maximum heat prevails elsewhere. As a culture station it is not happily located, and the Coast Range should be otherwise represented. In view of the considerations already set forth above, it appears to me that the extensive and important region lately opened up to settlement by the extension of the Southern Pacific Railroad toward San Luis Obispo, along the largest river of the Coast Range, the Salinas, is eminently entitled to consideration, it being a new and apparently most promising field for varied cultures. I submit herewith a proposition looking toward the establishment of a station, on the general basis as above outlined, by a donation of land in trust and the raising of a sum sufficient for the erection of buildings, on the part of Mr. J. V. Webster, of Creston, San Luis Obispo County. The land offered is situated within a few miles of the town of Paso Robles, and in my view will be as fairly representative of the culture conditions of the fine agricultural region of the Upper Salinas as could be readily chosen. I therefore respectfully recommend the formal acceptance of Mr. Webster's proposition at the coming meeting of the Board of Regents, and that the expenditure needful for further equipment and such work as the season will permit, be authorized.

Another most acceptable offer of a similar tenor comes from Senator A. Caminetti and others, offering a tract of land within a few miles (the exact location yet to be determined upon) of Jackson, Amador County. As that county is very nearly centrally located within the foothill region as above defined, and as personal examination has satisfied me that the soil and climate of the locations of which the choice is offered is as fairly representative of the foothill region at large as any one location that could be selected, I also recommend the acceptance of this offer, it being the only one that has come from that region, and being in every respect a fair one, besides being situated in a community anxious for information as to untried cultures.

I am in receipt of suggestions and offers of coöperation from various other points, notably from Tulare County, from Santa Barbara (the same as formerly communicated to you), and from the County of Los Angeles. None of these suggestions have as yet taken so definite a form as to call for a recommendation on my part at this time. But in view of the lateness of the season and of the short time remaining within which the appropriation for the present fiscal year can be expended, I urgently recommend that the power to accept appropriate donations for culture stations, and to take proper action thereon, be delegated to a committee that can be easily called together; since the necessity of awaiting the action of a regular meeting of the Board of Regents would defeat all further progress in the establishment of stations for this season.

I have in view one other station, the establishment of which will involve but little initial or current expense, and which would adequately represent the higher portion of the middle Coast Ranges. I refer to Mount Hamilton, the native vegetation of which shows unexpected possibilities in the way of cultivation at the height of four thousand feet. I have found at this altitude the native grapevine and a growth of oaks and other plants rivaling that of many interior valleys. Apart from the desirableness of thus facilitating the supply of life's necessaries to the *personnel* on the mountain, the success of cultures at that elevation would go far to show the latent possibilities of the lower ridges, now mere pasture grounds. I therefore suggest that so soon as the Mount Hamilton domain shall have been turned over to the Regents, operations looking toward at least a small culture plot be at once begun, so as, if possible, to gain a year's time in actual experience.

It should not be forgotten that besides these new stations and the one at Berkeley, three specially *viticultural* stations, based entirely on private munificence, are already in operation. Two of these are located on opposite sides of the Santa Clara Valley (at Cupertino and Mission San José), and one at Fresno. If these are maintained and the plans above outlined are carried out, we shall have *ten* stations in all to look after. This is a very respectable number, and it is obvious that it cannot be much increased without special strong reasons or, perhaps, additional pecuniary means. I estimate the current expense of maintenance of a general culture station of fifteen to twenty acres, once established and equipped, at between $2,000 and $2,500 per annum; and it is thus easily seen that the limits of the Congressional fund will very nearly have been reached when the present plans are carried into effect.

Respectfully submitted.

E. W. HILGARD,
Professor of Agriculture.

In accordance with the tenor of the above report, a special committee to consider the offers of sites for stations and to accept them when satisfactory, was appointed by the Regents. The three stations named below were thus established, and the following gentlemen were appointed "Patrons" of the same, with supervisory powers: For the Foothill Station, Hon. A. Caminetti, of Jackson, Amador County; for the Southern Coast Range Station, J. V. Webster, Esq., Creston, San Luis Obispo County; for the San Joaquin Valley Station, B. F. Moore, Esq., Tulare City, Tulare County.

From a bulletin (No. 80) issued August twenty-ninth of the present year, I extract the following passages relating to the progress made at that time in the direction indicated:

The constant demand for information as to the progress made in the establishment and work of our Experiment Stations, under the Hatch Act, renders it expedient to publish at this time a succinct account of the progress made and of the plans now definitely adopted. It may be stated that these run entirely within the lines indicated in a former bulletin (No. 78), but as that document may not be in the hands or may have passed out of the memories of many interested, its main points are given here for information:

Experimental work of the exact character set forth in the "Hatch Bill" has been carried on at the University of California since 1876. The first report of work done was issued early in 1877, and it has continued uninterruptedly ever since to such extent as the appropriations made from time to time by the Regents and the Legislature would permit. During the two financial years immediately preceding the present one the aggregate annual expenditure for experimental work has approached very nearly to the amount lately appropriated under the Hatch Act.

In several other States the State appropriations were withheld upon the passage of the Hatch Act, and the (subsequently discovered) failure of the latter to make an actual appropriation caused serious inconvenience in these cases and gave additional energy to the efforts, fortunately successful, to have the omission remedied by a special Act of Congress, which passed very early in the present session. Since this supplementary Act, however, left the provisions of the Hatch Act unchanged, it became necessary to expend within practically four months' time, and yet within the limits of the law, the full amount of the annual appropriation of $15,000, since any unexpended balance would be forfeited.

In California no withdrawal of the State aid from the experimental work occurred, or was intended, it being understood that the work would be carried on as before, but without special appropriations being asked therefor; and that, in the event of the passage of the Hatch Act, the funds thus made available would be used to increase the scope and efficiency of the experimental work; and, notably, that "Culture Experiment Stations" should be established in the various climatic divisions of the State, so far as the means at command would permit. This course was in accord with the expressed desire of the State Grange and other representative agricultural bodies, whose influence was exerted in behalf of the passage of the Hatch Act.

In pursuance of a report and recommendations on the subject, addressed by the undersigned to the President of the University early in March, 1888 (Bulletin No. 78), the Board of Regents promptly authorized him to take immediate steps toward the establishment of the long-contemplated outlying stations.

Shortly after the publication of Bulletin 78, tenders of land and of funds sufficient for the needed improvements were received from the following counties, in the order here named: Amador County, for the "Foothill Station;" San Luis Obispo County, for the station representing the Southern Coast Range region; Tulare County, for the San Joaquin Valley Station. Soon after, several suggestions and one definite offer (the latter from Mr. F. A. Kimball, of National City) were also received from the southern region. But a discussion of the time and funds at command led to the conclusion that it would be unsafe to involve ourselves in the establishment of more than three stations during the first year, and until experience should have yielded some more definite data in respect to the first cost and running expenses of such establishments. Moreover, the shortness of the time before the expiration of the financial year (June thirtieth) would render a full investigation of a larger number of localities, as to their fitness, physically impracticable.

In each of the above counties the choice between several tracts was given. Each of these was personally examined by the writer, two visits to each county being made, and the final choice was based upon the concurrent consideration of the points mooted in Bulletin 78, with that of convenient location and willingness of residents to give financial or other aid. A full account of these points would be too lengthy for the present publication, and is reserved for the annual report; but the subjoined summary statement regarding the establishment of and progress thus far made in the several stations (named in the order of their acceptance) will convey the information now called for.

1. *The Foothill Station.*—This station was established first, under the enthusiastic and efficient initiative of Senator A. Caminetti, of Jackson, Amador county. After much consideration of the respective merits of hills and valleys in the premises, the choice fell upon a tract situated about four and one half miles a little east of north of the town of Jackson, the county seat. According to the levelings of the Amador Ditch, which passes through it, and a topographical survey made by a volunteer party of University students, its

highest point is two hundred feet above the ditch, which itself is there at about one thousand eight hundred and fifty feet elevation; making the average height above the sea about two thousand feet. This, according to the best testimony available, is the height at which frosts are least liable to injure delicate fruits, including the citrus tribe; and the tract possesses the special advantage of including within its limits three of the most important soils of the foothills region, viz., the red "slate" soil, the granite soil, and the quartz gravel soil. Its natural vegetation embraces a very full assortment of the trees and shrubs of the lower "foothills," including the Buckeye and Toyon. The main tract of twenty-two acres was donated by Senator John Boggs, of Colusa. But as this lacked a representation of certain desirable features of soil and exposure, an addition of six acres was made on the west by a donation from Mr. McKay, and a tract of seven acres was added on the north by Messrs. Trabucco and Oneto, compensation being made them for the large standing timber.

The improvement of the tract was carried out on a very liberal scale by a committee of citizens. A new road was graded one and a half miles up to the land from the county road. The main tract was fenced with a board-and-wire fence, also grubbed and plowed. Pipes for water supply were laid from the ditch both to the central hill, on which a reservoir for irrigation is located, and to the higher hill, upon which the dwelling is to be placed, and from whence it will command a wide view among the mountains and over the Sacramento Valley, and as far as Mount Diablo. The two-story dwelling, with glass propagating house, as well as stable and tool house, are now in progress of construction in general accordance with plans furnished by the University.

The two exterior tracts have been fenced, and the reservoir of twenty-five thousand gallons capacity constructed at the expense of the station fund; a water power and pump will be placed in the ditch by consent of the ditch company, who also liberally agree to supply gratuitously the needed water. It is, however, intended to use irrigation as sparingly as possible, in order to prove what can be done without it in the foothill region.

2. The station for the *Southern Coast Range* has been established under the initiative of J. V. Webster, Esq., of Creston, San Luis Obispo County, and is intended to represent the largest interior valley of the Coast Range, drained by the Salinas River. In its lower portion the valley of the Salinas, three to four miles wide, is open to the coast winds, which control its climate. Above Soledad it gradually contracts and ascends considerably, being for some distance not much wider than the shallow, sandy river bed, although not flanked by high mountains. Above San Miguel the valley again expands, and finally broadens out into a level or slightly undulating country, traversed by the upper tributaries of the Salinas, chief among which are the Huer-Huero and Estrella. From the latter stream the whole region, picturesquely dotted with oak groves that give it a park-like appearance, is often designated as "the Estrella Plains," although that designation belongs properly to the more restricted and partly timberless area immediately adjoining Estrella Creek itself. From above Templeton (the present railroad terminus) to San Miguel, its length is about twenty miles, while from the Salinas, near Paso Robles, eastward to the Cholame Range, its greatest width is about fourteen miles. As within these limits there is scarcely any waste land, and the soil when well cultivated is very productive without irrigation, this region constitutes one of the largest continuous areas of agricultural land in the State, outside of the Great Valley. As yet it is but thinly settled and its productive capacity imperfectly understood, hence it is eminently worthy of being made the subject of exhaustive culture experiments.

From among several desirable locations offered in this region, a tract of twenty acres, situated within two miles of Paso Robles, on the plateau, about three fourths of a mile east of the Salinas River, and eighty feet above it, and offered by Mr. J. V. Webster, was finally accepted. A subscription toward the erection of the necessary buildings was raised by Mr. Webster, chiefly among the citizens of Paso Robles and Templeton and neighborhood.

The tract is a parallelogram, one thousand seven hundred by five hundred and twelve and one half feet, and fronts on the new public road from Paso Robles to the Huer-Huero settlements. Like the Foothill Station, it contains representations of three of the most important soils of the region; and the larger part of it (having the light, sandy soil of the plains) was quite heavily timbered with the prevalent "blue oak" (*Quercus Douglasii*), here mostly not distinguished from the white oak (*Q. lobata*), which occupies only the lower ground. This timber has (with the exception of a few fine trees) been grubbed out, the stumps cut off and taken from the holes, and the latter leveled over. A substantial six-board plank fence, with redwood base, so constructed as to be rabbit proof, has been built around the tract, and an "automatic" gate placed at the front entrance. A well has been dug near the site of the dwelling, in which water has been reached at the depth of ninety-five feet. This is the only well for many miles on the plateau level, and itself demonstrates a fact of considerable importance to the region. The supply is thought to be large, but awaits the putting in of a deep-well pump before it can be definitely gauged.

Plans for the dwelling and outbuildings have been forwarded to Mr. Webster, who will push their construction with his accustomed energy.

3. In the establishment of the *San Joaquin Valley Station* the initiative was taken by Tulare Grange, among whose members Messrs. B. F. Moore and William F. Stewart have been especially active in forwarding the work, serving as a committee whose task alone in accompanying the writer to the numerous locations offered was not light. The selection was difficult on account of the highly specialized character of the soils of the Kaweah Delta, within which a location fairly representative of the "plains soils" from Kern to

Stanislaus was not easy to find. It is believed, however, that a thoroughly representative tract has been found on the low ridge on which Tulare City is located, about a mile and a half southeast from the town, where Messrs. B. F. Moore and J. S. Gould offered a twenty-acre tract, so selected as to include a few acres of "alkali land" (the reclamation of which will form one of the most important problems to be solved), together with the sandy loam with a light hardpan foundation that scarcely varies in its nature, and (outside of the Fresno region) forms the bulk of the soil of the San Joaquin plains.

A guaranteed subscription of $3,000 toward the cost of the erection of buildings was promptly made by citizens of Tulare City and neighborhood. Plans for these have been forwarded, and their construction, it is understood, will commence immediately.

Irrigation being essential in this region, and ditch-water being uncertain in supply as yet, it was concluded to bore a well, or several if necessary, in order to reach and utilize the abundant water supply which is commonly found here at about twelve feet depth, but which becomes apparently inexhaustible when the gravel stratum lying at thirty to fifty feet depth is tapped. A ten-inch well has therefore been sunk to the depth of sixty feet, with the usual result of an abundant rise of water to within twelve feet of the surface. A "triple-action" irrigating pump with horse-power has been sent on and will shortly be put up under the superintendence of Mr. B. F. Moore, the donor of the land, who has also rendered most efficient services in overlooking the putting up of the fence, which is a "six-board," like that at the Coast Range Station, and will likewise be provided with an "automatic" gate. Mr. Moore proposes to irrigate and plow the land, as a preparation for the season's work, so soon as the pump and power shall be in position.

Occupation of the Stations.—Considering unavoidable as well as unforeseen delays, it is probable that none of the three stations will be ready for occupation before October first. It is, of course, highly desirable that the coming season's work shall be laid off and begun at the earliest moment possible, and the selection and training of men competent to serve as foremen in charge has been in progress for several months.

It is perhaps hardly necessary to specify the experimental cultures to be at once initiated at these stations. Roughly speaking, they will come mainly under the following chief heads: Orchard fruits, grape varieties, forage plants, cereals, and other miscellaneous culture plants. In view of the small area of the station grounds, and of the existence of special stations for that purpose, forest trees will not be experimented on to any large extent.

The Experiment Station Building at Berkeley.—In conformity with the recommendation made in Bulletin 78, a handsome and substantial building containing the necessary laboratories, work-rooms and offices for the experimental work has been erected on the University grounds at Berkeley; partly on foundations already existing and used as a viticultural laboratory. The dimensions of this building are forty-six by ninety-two feet; three brick-walled cellars with concrete floors underlie one half of the brick basement, which has six work-rooms and two store-rooms. The superstructure is of wood. The main floor is occupied by the chemical laboratories, a large collection room (also to be used for the instruction of classes in agriculture and viticulture), and the Director's office. The second floor contains offices and work-rooms for other than chemical work. Two of these will at once be occupied by the Assistant Superintendent of the experimental grounds at Berkeley, Mr. E. J. Wickson; while others remain to be occupied hereafter by such needful additions to the working force as will obviously soon be required, among which a "State Entomologist" is perhaps the most pressing need. A spacious attic will afford additional storage and work-room for certain purposes when necessary.

The laboratories, collection and work rooms are now being fitted up with the necessary work tables, cases, and shelving, partly new and partly transferred from the rooms heretofore occupied elsewhere. A complete "steam apparatus" (steam bath for chemical use, such as digestions, evaporations, etc.), with connections for steam-drying chamber, distilled water, and other distillations, has been ordered from Germany and is expected to arrive within a month.

It is hoped that the foregoing statements will indicate that the time which has elapsed since appropriations became available under the Hatch Act has been diligently utilized.

E. W. HILGARD.

BERKELEY, August 29, 1888.

The programme laid out in the bulletins just quoted has since been followed and perfected with but few changes of any moment. The reservation made with respect to possible unforeseen delays has also been amply verified. None of the stations were ready for occupation by the foreman as early as October first; those of the Foothill and the Southern Coast Range Stations were sent to their respective posts on November first; Tulare Station will probably not be occupied by the foreman, Mr. J. Forrer, before December fifteenth, as at this date the out-buildings alone are available, and the construction of the dwelling is but just begun; in other respects the condition of things remains the same as stated in the last bulletin. At the Foothill

Station the dwelling is under roof, but the construction of the barn may be delayed until spring, in consequence of the difficulty of hauling lumber during the wet weather. It is proposed to utilize some old buildings existing in the neighborhood as a shelter for the team during the winter. It is, however, expected that at both stations the planting operations will be fully carried out, so far as this can conveniently be done in one season. The foreman of the Foothill Station, Mr. Geo. Hansen, is on the spot and is actively pushing the needful preparations.

The buildings at the Southern Coast Range Station have been completed and the foreman, Mr. R. D. Cruickshank, placed in possession. The timber is being cut up and its available portions piled out of the way, without burning anything on the ground to be planted; so as to insure a fair comparison of the several soils on the tract with those of the country at large. The well has been deepened to one hundred and four feet and now has six feet of excellent water; the pump and horse-power have been put in place, and whenever a test of the water supply shall have been made a tank adapted to the circumstances will be put up so as to supply water to any part of the tract, in which the differences of level are only slight. A good team of horses has been purchased at a cost of $350, also double and single harness, and, besides the farm wagon, a light one-horse road wagon, needful for rapid locomotion and communication with the railroad depot.

The outfits of agricultural and other implements, purchased in June last, have been forwarded to all the stations and are stored, ready for use whenever required. A large number of fruit trees (budded in the propagating grounds at Berkeley on seedlings purchased last spring) are ready for transplanting to the stations, kinds not represented to be supplied from responsible nurseries. A large collection of seeds (mostly gathered on the grounds at Berkeley) is similarly in readiness for use at the stations. Collections of vine cuttings for the same purpose were made last spring, and were rooted partly on the grounds of Patrons Webster and Caminetti, near the stations, partly on the grounds of the Ladies' Silk Culture Society at Piedmont, near Oakland, remote from any possible source of infection with vine pests. Additional varieties of vines, not obtainable last season, will be procured this winter, so as to start out with not less than one hundred of the more important grape varieties, the number to be gradually increased as experience may indicate.

The *Viticultural stations* under private patronage, of which at present there are three, have also been supplied with additional important varieties, and all will doubtless furnish important material and data next season. During the vintage season just past, important data have already been derived from both the station at Fresno, under the patronage of Messrs. E. B. Rogers and Dr. J. Eshleman (under the personal management of Mr. E. Robson), and from that at the Mission San José, under the patronage of Mr. Juan Gallegos, although both are only in their second year.* But a most comprehensive and varied supply of valuable material has been furnished by the Cupertino station, under the patronage of Mr. John T. Doyle, now in its fifth year, and having in bearing most of the one hundred and twenty varieties now planted or grafted within the area devoted to the purpose by

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*Twenty-four varieties were supplied from the latter locality, and five from Fresno.

Mr. Doyle, besides several other kinds represented in his vineyard at large. The increasing age of the vines permits of the use of larger quantities in the experimental fermentations, and thus makes the results more directly applicable to large-scale practice; while at the same time the quality of the resulting wines is naturally better. From this locality grapes of sixty-four varieties, in lots varying from one hundred to two hundred pounds, have been subjected to vinification at the laboratory; and with the results of three seasons now already before us, the main questions relating to some of the kinds are already so well settled that it seems unnecessary to repeat the vinification experiments with respect to quite a number, thus leaving room for more numerous trials from other localities.

It would be exceedingly desirable that the number of such special viticultural stations, of which the cost to the University is but slight, should be greater, and that they should be more widely scattered over the State. Additional offers of this character have been received, and will receive special attention in the near future.

The work in the *Viticultural laboratory*, based mainly upon material and data supplied from these stations, has during both the two vintage seasons been continued by Assistants Jaffa and Colby, on the former plan; viz.: the vinification of lots ranging from one hundred to two hundred pounds of numerous varieties of grapes grown in different localities—in order to ascertain the peculiarities and consequently the mutual adaptations of varieties, climates, and soils; as exemplified in former special reports on the subject. Notwithstanding many objections, captious and otherwise, against the methods of work pursued by me in this matter, I have found no reason to deviate materially from this plan; not only because no better has been suggested that is practically feasible, but mainly because the results obtained, particularly in respect to climatic adaptations, have been so definite and practically decisive as to serve as a perfectly definite basis for action. While it is true that it would be desirable to have all the operations—planting as well as laboratory work—on a *somewhat* larger scale, yet I am satisfied that with any very material enlargement, the increased cost and difficulty of conducting the experiments would in a very large measure offset any additional advantages to be derived from them; and that for the preliminary work now most needful, it is unnecessary either to plant the grape varieties by the acre or to vinify them by the ton. It will be time enough to do this when, after settling the broad, general questions that beset the grape grower at this early stage of the industry, we shall have come down to the closer study of particular varieties, and the methods of vinification adapted to them, for the production of certain definite qualities. In the present state of the wine industry and particularly of the wine trade, such detailed experiments, however interesting to individuals, are overshadowed in importance by the broad and ever repeated question, "What to plant?" This is the pressing and burning question of the day; the next is, how to insure sound and acceptable wines under the industrial and climatic conditions prevailing in this State. When these two fundamental points are disposed of, it will be time enough to experiment in detail and on a large scale, on the subject of particular and local questions. It would not be justifiable to go to the enormous expense and complicated work of large-scale vineyards and experimental wineries until the elementary questions are disposed of; and for these the indications obtained by the work now being done by us are amply decisive. For further discussion and exemplification in the premises, I respectfully refer to the partial report of viticultural work on "Methods of Fermentation," already referred to above.

The increased facilities now afforded by the more ample space and perfected appliances for this branch of the work (that were only partially available when the vintage of this year began) will enable us to make much more rapid and satisfactory progress hereafter; provided that the *personnel* in charge of the same shall be proportionally increased in number and efficiency. As now organized, the time I can devote to the subject is far too limited to enable me to derive from the work more than a small part of the results it really contains and evolves; and, as I have elsewhere stated more in detail, I consider that the appointment of a competent and broadly educated person to take *entire* charge of the viticultural work, is now the most pressing need of the Agricultural Department as a whole.

In conclusion, I cannot but express my gratification at the continued and increasing interest manifested in the work of the Department by the agricultural population, as tangibly manifested in the liberal donations made for the establishment of the outlying Culture Stations. It is obvious that these will in a measure act as missionary institutions in their respective regions, and will thus form new centers from which progressive ideas in agriculture and in technical education will radiate, and thus also extend the influence of the University and the interest in its industrial departments. In order that this influence may be successfully exerted, however, it is of the utmost importance that there should be no *lâches* in the full and judicious utilization of the opportunities thus afforded. The Hatch Act has enabled us to perfect to a very satisfactory degree the appliances for work, both at the central and outlying stations. What is now more than ever needed is a sufficiency of competent and efficient workers to *use* these appliances so as to make the results felt all over the State. The work, with all its multitudinous details—scientific, practical, and administrative—has now far outgrown the ability of a single head to do more than give direction to the several branches, as has been unfortunately made evident by the forced omission of the publication of last year's Report. Such delays in the utilization of the results of work intended primarily for immediate use are most damaging to the cause of progress and to the reputation of the work, and should not be allowed to occur. The only way to prevent this and to insure the full use of our opportunities is a farther subdivision of the field, so as to cultivate more profitably and thoroughly each of its parts. I have already, in the present report, as well as in special communications made heretofore, indicated what I consider to be the most immediate needs in the premises. The viticultural work requires the undivided attention of a fully competent, broadly educated man; and the entomological work should be similarly provided for. With proper men in these positions, the California Experiment Stations can be made an example of broad, efficient, and practically useful work.

Respectfully submitted.

E. W. HILGARD,
Professor of Agriculture and Director of the Experiment Stations.

MECHANICAL ENGINEERING AND DRAWING.

To the President of the University of California:

SIR: The present condition, progress, and wants of the Department under my charge will be better understood by a statement of my aim, regarding its scope and organization, towards which my efforts have been consistently directed, and which has guided me in apportioning the specific State appropriations received from time to time from the Legislature.

The Department of Mechanical Engineering may be considered under four heads:

I. Lectures, and general instruction.

Bearing in mind that special construction is confined to the Senior year only, it becomes necessary that the student should enter with that preparatory knowledge on which instruction during the Senior year is based. This comprises a complete mathematical course, analytic mechanics, theory of elasticity (strength of materials), hydraulics, and thermodynamics.

II. Drawing room for special instruction in the designing and placing of structures and machines. Preparatory subjects required: Descriptive geometry, graphostatics, and a knowledge of instrumental drawing and graphical methods.

III. Shops for building, including all reasonable facilities to build apparatus and machines for the laboratory.

IV. Laboratory, to consist of five parts or divisions:

1. Office, drawing room, storage rooms, and rooms for collections of articles of manufacture.
2. Laboratory for miscellaneous experiments.
3. Laboratory for hydraulics.
4. Laboratory for steam or gas engineering.
5. Laboratory for electric engineering.

How far I have advanced towards the above aim will appear from the following:

I. The course in strength of materials (theory of elasticity) is given by Professor Soulé during the first term of the Senior year. Hydraulics and Thermodynamics are given by myself during the same term. The legitimate time for that special instruction, which characterizes the department, is therefore practically reduced to the second term of the Senior year.

It is not my intention at present to urge the matter, but I am hopeful that this difficulty will find its proper solution with the Faculty as soon as possible.

II. In addition to the Drawing Department, which now covers all the preparatory requirements given above, there is wanted a special instructor for mechanical engineering designs, etc., who must be a skilled draughtsman and designer in mechanical engineering.

III. Our workshops are now complete, offering every desirable facility for instruction and building as an auxiliary to the laboratory.

IV. The laboratory building at present offers only the facilities designated above as divisions 1 and 2.

The experimental room contains one Riehle vertical testing machine of fifty thousand pounds capacity; a testing machine for wires; a nine horse power engine, and other apparatus for experiments of a miscellaneous character. The room is already crowded, and otherwise not fit for experiments in hydraulics, steam, or electric engineering.

It is of vital importance that the scope for original or laboratory work should be extended. The publication of valuable and useful results engages the interest and coöperation of the public; and the work done in the laboratory, as an educational means, is invaluable to the students, and cannot be replaced by any other method; and I wish it to be well understood that I hold this latter consideration as the one claiming primary importance, and that the publication of the results is not in itself the objective point.

The laboratory must be extended to furnish the room for hydraulic and electric work. The first requires a special plant, which has for its object the transmission of power at a uniform rate of velocity—an essential condition for a wide range of tests in hydraulic, electric, and other experiments; and also to provide for a liberal supply of water under varying conditions. Our present supply is just sufficient for ordinary wants, and the large quantities of water going to waste in hydraulic experiments will never be furnished by future facilities in Berkeley.

The above is accomplished by means of a compound centrifugal pump of our own construction and build, an adjustable tank with overflow and a partial turbine, so as to make available a large quantity of water over and over again without going to waste.

During the last two years we have added to our stock the following:

A Stevelyn sub-heater and a Monitor steam injector.
Crosby's steam card indicator.
Keuffel & Esser planimeter.
Bausch & Lomb microscope.
A small experimental dynamo.
Sir W. Thomson's current, potential, and reflecting galvanometer, rheostat, condenser, shunts for galvanometers and two accumulators, switches, and batteries.

The following work was done in the laboratory during the last two years:

1. Experiments for resistance and pressure of a new hydraulic step, published in Bulletin No. 2.
2. A new speed indicator for short time intervals, published in Bulletin No. 2.
3. Tests for tensile strength, limit of elasticity, etc., of a large variety of wire ropes, manufactured by the California Wire Rope Works, San Francisco. To be published.
4. A variety of tests made to determine the influence of twist and distortion on the tensile strength of wrought-iron bars.
5. Tests for compressive resistance of a variety of Portland cement.
6. Miscellaneous tests for tensile and compressive strength.

Respectfully submitted.

F. G. HESSE,
Professor of Mechanical Engineering.

Mining, Metallurgy, and Assaying.

To the President of the University of California:

Sir: In compliance with your request, I have the honor to submit the following report concerning the "progress, condition, and wants" of the Department under my charge. The work of the Department may be conveniently considered under the three heads of instruction, improvements, and original work.

INSTRUCTION.

During each of the two years which have just passed, I have conducted the following courses of instruction:

Mining, three lectures a week for the entire year;

Metallurgy, three lectures a week for the entire year;

Assaying, laboratory practice, six hours a week for the entire year;

Metallurgical laboratory, six hours a week for the second term of each year.

The details of these courses are given in the University Register, and need not be repeated here.

At present there are seven students in the class in mining, ten in the class in metallurgy, eleven in the class in assaying, and the class in metallurgical laboratory practice is not yet organized, as it comes in the second term. Besides these the College of Mining includes one graduate student pursuing advanced work and the students in the three lower classes who do not take up their technical studies till the Senior year.

My students have shown such interest, industry, and devotion to their work that the labor of instruction has been a pleasure rather than a task. I regard this interest as largely due to the important part which laboratory work takes in our scheme of instruction, and the excellent facilities which the Department is now prepared to offer to students. I take pleasure also, in calling attention to the fact that graduates of the Mining College are already taking important and responsible positions in their profession in spite of the short time that the Department has been organized.

IMPROVEMENTS.

During the past two years all my time not otherwise occupied has been utilized in making detailed plans and superintending the equipment of the metallurgical laboratory. As it now stands this laboratory is on two floors. The upper floor is fitted up with a Dodge rock breaker, a Krom fine crusher, platform scales, a set of sizing screens, a dry concentrator, and all the conveniences for the coarse crushing and sampling of ores. After coarse crushing and sampling, the ores are delivered to the machines on the lower floor. These consist of a battery of three five hundred pound stamps, which was specially constructed at the Union Iron Works so that the mortar could be used either with single or double discharge, either for dry or wet crushing, and either with or without gold plates, so as to adapt it to as wide a range of work as possible. With silver ores the pulp is run into sand tanks and thence discharged into amalgamating pans, settlers, etc.; with gold ores it is run over silver-plated copper plates, and thence to a Frue concentrator. This machine, of full size, was specially made for the University, and may be run either with side or end shake. The lower floor of the laboratory is constructed entirely of concrete, with a slight grade for drainage, so that it is easily kept clean and dry. It also contains settling tanks of concrete. As our water supply is limited, the clear water is pumped back to the battery by a centrifugal pump and is used over again.

This arrangement allows all the tailings and by-products to be saved, weighed, sampled, and assayed, and if desired subjected to further tests. The laboratory is supplied with power by a fifteen horse power Westinghouse steam engine. All of the above plant is in a thorough working condition, and several successful runs have been made with it by my students.

I am at present busy with the erection of some additional machines for the dry crushing of ores. These are a pair of Krom's swinging-pillow-block steel rolls, and a six inch Sturtevant mill. These machines will be arranged to discharge to a common pit, whence the ore will be lifted by a bucket elevator to properly arranged sizing screens on the floor above. The screens will be contained in a dust-tight housing, and the whole system will be provided with a suction fan and dust bags to avoid loss and inconvenience from dust. Two three-compartment Hartz ore jigs are being erected, and will be arranged for coarse and fine jigging, and properly arranged sorting boxes and settling tanks will be provided. As soon as this work is completed it is my intention to add a small reverberatory roasting furnace and the necessary outfit for experiments on the leaching of ores.

Great pains have been taken in the selection of the individual machines to choose those best adapted to the special needs of our students, and, as to size, to hit the happy mean which shall make them capable of real work, without, on the one hand, being so small as to be mere toys, or on the other, being so large as to be cumbersome and expensive. Special attention has been given to the arrangement of the entire plant so as to cover a wide range of work at the least outlay. With the completed plant I am convinced that the University will be provided with a working laboratory that will compare favorably, so far as the special needs of our students are concerned, with anything I have seen in the United States.

I have also to report the gift to the Department of a large number of working drawings of the standard mining and coal dressing machinery in use at his large anthracite coal mines by Eckley B. Coxe, Esq., of Drifton, Pennsylvania. The same gentleman has also promised for our laboratory the valuable gift of a working model of a screening machine of his invention, largely used in Pennsylvania.

G. G. Allan, Esq., of Nevada City, California, has kindly made for the special needs of our work a three-foot continuous amalgamating pan, and presented the same to the Department. This machine is in use at Nevada City for amalgamating gold ores, and will be a valuable addition to our laboratory.

ORIGINAL WORK.

Connected with the many branches of the mining industry are numerous unsettled problems which the busy practitioner has no time to investigate, which are yet important enough to involve in the aggregate (annual) losses of many thousands of dollars. It has been thought that the Department could prove itself of service to the mining interest by taking up from time to time some of these neglected subjects and pushing them to some satisfactory conclusion. Several such investigations are under way, and the results of one of them have just been published for general circulation by the Department, as a University Bulletin, "On the Losses in Roasting Gold Ores, and the Volatility of Gold." The article has also been published in the transactions of the American Institute of Mining Engineers, and reprinted in full in the Engineering and Mining Journal, of New York. Numerous requests have also reached the department for copies of this bulletin, not only from our own country, but from England and Germany as well. This would seem to indicate the general demand for work of this character.

It is my desire to be able to add, from time to time, such published records of original work as shall be of value to the mining industries of California; in fact, in view of the liberality of the State in providing for the equipment of the Department, I regard it as one of my most important duties.

NEEDS OF THE DEPARTMENT.

The additions to our working plant that I have outlined above may be just about completed, according to my estimates, with the funds appropriated for that purpose by the State Legislature. I hope to have the whole in complete running order by the end of the present academic year. When this is done the whole working plant of the Department—buildings, apparatus, and machinery—will have been completed entirely by means of special legislative appropriations, and without the slightest aid from the general funds of the University.

Up to the present time the Department of Mining and Metallurgy has received from the general funds of the University, outside of the salary of the Professor in charge, the sum of $50 per month for laboratory assistance.

For the present year, for the first time, half the time of a fireman has been allowed the Department, and I have already recommended that the sum of $900 for laboratory assistance be allowed for the present year.

For the ensuing year, in order to care for and utilize the extensive and valuable plant which will then be completed, and to carry on the work of the Department already mapped out, the sum of $1,800 for laboratory assistance, and $600 for supplies, materials, and running expenses, will be urgently needed. A much larger sum might be utilized to good advantage, but with economy the sum mentioned will suffice for the present to enable the Department to do a great deal of valuable work. With less than this, the work of the Department will be greatly crippled and the usefulness of its valuable plant seriously impaired.

Respectfully submitted.

SAMUEL B. CHRISTY,
Professor of Mining and Metallurgy.

Civil Engineering and Astronomy.

To the President of the University of California:

Sir: I have the honor to report to you regarding the condition and progress of the Department of Civil Engineering and Astronomy as follows:

The number of students taking the Course in Civil Engineering is gradually increasing, and the number of graduates following this line of work, and practicing their profession, is a large and gratifying percentage of the entire list of graduates in this course of study.

The new Freshman class contains sixteen young men who have chosen civil engineering for their curriculum.

Besides those students enrolled as regular candidates for a degree, we have had, for many years, quite a number of persons desiring to take a part of the full course, as the surveying instruction with field practice, and others who wished to follow some special line of work in the engineering profession. All applicants of mature mind and definite purpose have been encouraged in such ambition, and their acquirements have been gratifying to us.

Some of our most proficient and promising young men have been those who, from lack of means or from considerations of mature age, have decided to take a special, rather than a regular, course in Civil Engineering. A new feature has been introduced into our surveying course, viz.: while giving enough hours per week of field practice to acquaint our students with surveying instruments, their adjustments, general use, etc., Mr. Raymond reserves the greater part of the field work until the first month of the summer vacation, when the class voluntarily goes into a University surveying camp, and does continuous work for many consecutive days; thus obtaining a knowledge of the organization, equipment, transportation, management, and supply of field parties, which could be gained only by such experience; besides deriving the benefit of a far greater amount of time and continuous application than could possibly be secured during their Berkeley life, when hours of practice are of necessity scattered throughout the week.

The experiment has proved to be a great success, and has been conducted not only voluntarily, but enthusiastically by the students.

I would suggest that this new order of things be officially adopted and prescribed, so that hereafter the vacation exercise shall become a recognized part of the college work in civil engineering.

In addition to the plotting of surveying notes made in the field, and to the mapping, all of which has been done under the instruction of Mr. Raymond, the class has latterly practised modeling in plaster of Paris, producing thereby a solid, embossed representation, or relief, of portions of the topography of the earth. A relief of the University grounds has been made, and the several college buildings, roads, groves, etc., accurately drawn upon it, so that at a glance the exact condition of the whole University domain may be seen.

A topographical map (with contour lines two feet apart) has also been constructed, representing a large part of the same surface.

A new course comprising the theory and practice involved in specifications and contracts and business law, as related to engineering and architecture, has been offered by me, and taken during the past year.

The Students' Observatory has been completed, and the apparatus adjusted; so that during the last academic year a class voluntarily took a course in observatory practice.

This exercise has since been prescribed by the Faculty of the College of Civil Engineering for all regular students in that course, and eight young men are now working in that line. The observatory practice is supplementary to the instruction in Practical Astronomy, Geodesy, Navigation, and Nautical Astronomy, as given in the lecture-room; and comprises the use of the sextant, chronometer, transit, and astronomical tables; and also all such observations, calculations, and reductions as are required in the arts of Geodesy and Navigation.

Any one having mastered this course in our observatory, requires nothing more than that experience which comes only with actual service in the field or on the sea, to successfully take part in geodetic surveys or to navigate a ship.

An excellent equatorial telescope, filar micrometer, and spectroscope are at the service of advanced students.

During the last year a number of young men acquired considerable proficiency in the use of this apparatus, and made gratifying studies of the more interesting celestial bodies.

The Students' Observatory has proved to be, not only a useful and necessary supplement to the Civil Engineering Course, as connected with the determination of time, latitude, longitude, azimuth, and other geodetic operations, but also a powerful inducement to begin original observations and to conduct independent readings, etc.

In order to do our share of creating an interest in the University on the part of the public, and to cause our citizens to feel that we desire to render the institution as useful and coöperative as possible, this Department has thrown open the doors of the Students' Observatory to the public, giving also due notice of the same, on the second and fourth Monday evenings in each month of the academic year, when weather permitted.

The fine six and a quarter inch achromatic refracting telescope, equatorially mounted, has been employed to show the wonders of the heavens; and short lectures or descriptions of the various objects of general interest have been given in connection therewith. The telescope has been very greatly employed in this way by public visitors. Since the opening of the observatory, more than one thousand persons have been enrolled in the visitors' book, not including students of this University.

An instructor in freehand, topographical, and civil engineering drawing, to be attached to the Department of Civil Engineering and Astronomy, is very much needed at present. The time of the instructor in mechanical drawing is fully consumed by his existing duties; so much so that Mr. Raymond has to give a part of the energy, which he would otherwise devote to other and more special work, to instruction in certain branches of civil engineering drawing. The increasing number of students, and the proper development of the curriculum, demand the services of such additional instructor.

The rooms assigned to this Department have been for years inadequate to its needs, inconvenient and ill adapted to its use. As it is, a large amount of costly surveying apparatus must be kept on the fourth floor of a perishable wooden building, and must be carried up and down three flights of stairs at each field exercise. It is probable that little or none of this apparatus would be saved in case the building took fire and was consumed.

The Department to-day possesses no draughting-room of its own, in spite of the fact that drawing is such an important part of the curriculum of any properly arranged College of Engineering. It is extremely desirable to have a drawing-room with excellent illumination, and so placed that the instructor may pass directly from the lecture-room to the room where the practical exercise related thereto is exemplified in drawings and construction designs.

I therefore respectfully and urgently request that such provision be made at the earliest practicable moment for this Department. In all other particulars than those above mentioned, the College is in a very satisfactory condition.

Respectfully submitted.

FRANK SOULÉ,
Professor of Civil Engineering and Astronomy.

MILITARY SCIENCE.

To the President of the University of California:

SIR: In answer to your request of October 22, 1888, regarding the progress, condition, and wants of the Military Department of the University, I have the honor to submit the following:

I assumed charge of the Department by orders from the War Department, on September 23, 1886. The duty of superintending a Military Department of a College or University is a radical departure from the work ordinarily required of an officer in his relations with enlisted men of the army. In fact, he has to wean himself entirely from the methods he was wont to pursue, and learn to administer discipline under novel conditions. The *personnel* of his new command is of a decidedly higher order intellectually and socially, with whom the acquirement of military knowledge is an incident and not an object.

The ordinary rigid and effective means of enforcing discipline are wanting. He finds himself in a position where he has to substitute for the convincing argument of the guard-house the exercise of considerable tact and diplomacy. The military course of instruction is, as it should be, compulsory for all able-bodied students. The very fact, however, of its not being voluntary deprives it of the essential element of efficiency in all militia and volunteer organizations—enthusiasm. It is the absence of enthusiasm that makes the work of the officer at the head of this Department a rather responsible one. He has to compensate for this absence by devices and means original with himself.

I found the Department when turned over to me by my predecessor, First Lieutenant Jas. A. Hutton, Eighth United States Infantry, in good condition. Just previous to my assuming control, the Board of Regents had passed a resolution reducing the time of required military instruction for the Senior class from two hours to one hour a week. To conform to the new conditions I took the Senior privates out of the battalion altogether, and substituted for the field work which they had previously been required to perform one hour's theoretical instruction a week. Such of the Seniors as have been made cadet commissioned officers of the battalion have each year, in view of the honor conferred, consented to perform the two hours' field work per week required of the other classes. Some of the cadet officers voluntarily take the theoretical course in addition to the field work, thus performing three hours of military work a week instead of one as required.

The War Department two years ago issued an order requiring an inspection to be made by an officer of the Inspector-General's Department of the Army, once a year, of the work done in the Military Departments of such Colleges or Universities throughout the country as have an officer of the army on duty. Such inspecting officer is required to make a written report of his inspection to Army Headquarters at Washington. In accordance with the above mentioned order an inspection of the Military Department of the University was made in May, 1887, and in May, 1888, by Lieutenant-Colonel Robert P. Hughes, of the Inspector-General's Department, U. S. A. In his inspection of May, 1888, he was so impressed with the military capacity displayed by one of the cadet Captains—Gaillard Stoney, class of 1888—that he recommended to the Inspector-General of the Army that cadet Stoney's name be submitted to the President of the United States for commission as a Second Lieutenant in the Army.

The course for the Senior class consists of theoretical instruction in Wheeler's "Art and Science of War" and Wheeler's "Elements of Field Engineering." The course for the other three classes consists of practical instruction in *squad*, *company*, and *battalion* drill, together with a course of lectures on general military subjects at such periods of the year as are too inclement for outdoor exercises. Instruction, in addition, in target practice is given once a week—after drills on Wednesdays—to those who wish to avail themselves of the same. There was, at the time of my assuming command, a range of two hundred yards. I have had the range extended to admit of firing at distances of three hundred and five hundred yards. A serious drawback to attaining satisfactory results in this direction is the need of the latest pattern arms of precision and of a larger supply of ammunition. The War Department was applied to for the required pattern of arms, but it refused to supply them. The Government allowance of ammunition is but one thousand rounds. The need of a greater supply has been represented to the War Department, but without avail. The Government finds itself restricted in such issues by limited Congressional appropriations.

In the two years that I have been superintending the Military Department of the University it has been made manifest to me that the said Department can be made to subserve many excellent ends in the internal economy of University life. Aside from the disseminating of technical knowledge, great and important in itself, it has peculiarly within its reach the accomplishment of a far higher end—the establishing of a healthy, manly *esprit* among the student body.

The detailing of an officer of the army to perform the duties of head of the Department of Military Science is, or should be, a happy fact for the University. His position is unique. He is vested with all the rights and prerogatives of a member of the Faculty, and derives all the virtues and benefits pertaining thereto. He possesses, however, at the same time all the advantages of one who is still identified with the outer world. His dual capacity of member of the Faculty and officer of the United States Government, combined with the fact that he alone of all the officers of the University is brought regularly in contact with all four classes, makes his influence a not inconsiderable one. With an enterprising conscientious officer the work before him is one of greater possibilities than is at first apparent.

The expense incurred by the State in maintaining said Department is most trifling. The average yearly cost of its maintenance is less than $200. The services of the officer of the army at its head are, through the graciousness of the General Government, given to the State gratis.

One of the great needs of the Department for over a year has been additional arms and accoutrements. The United States Government supplied one hundred and fifty arms and accoutrements for use by the battalion. As there are over two hundred students enrolled this supply does not meet the demand, and the Department has in consequence been considerably embarrassed. It has, however, just been learned that, through the efforts of Congressman Morrow, and his representation of the needs of the University to the Secretary of War, the latter has given an order for the issue of one hundred more arms and accoutrements.

The most important need of the Department is an *armory*. The arms are at present stored in a very unsuitable place in the basement at the north end of North Hall. It is damp and illy adapted in every way. There is no place where the students can change their uniforms, and they are, in consequence, subjected to grave inconvenience. An office for the use of the commandant is also a serious need. A separate permanent building of some durable material—preferably brick and stone combined—should be built as an armory, the said building to include an office, dressing rooms, etc. Such a building, besides serving a most useful end, could be made, by adopting a suitable military style of architecture, a most picturesque addition to the University grounds.

A small, but select military library for lecture purposes and purposes of reference is a much felt want. It should be kept in the military office, where it would be readily accessible for consultation. A sum of less than a thousand dollars would meet this requirement.

For information as to the condition of the Department I respectfully invite attention to the official reports of Colonel Hughes, Inspector-General, to the War Department, copies of which are herewith inclosed.

Respectfully submitted.

GEO. F. E. HARRISON,
First Lieutenant Second Artillery,
Professor of Military Science and Tactics.

MISCELLANEOUS REPORTS.

Lick Observatory.

Extracts from the Annual Report of the Director.

To the President of the University of California:

Sir: I have the honor to submit to you my first annual report as Director of the Lick Observatory of the University of California.

The Lick Observatory was legally transferred to the Regents of the University by the Lick Trustees on June 1, 1888. The formal ceremony of transfer took place on Commencement Day (June twenty-seventh) at Berkeley.

STUDENTS IN THE COLLEGE OF CIVIL ENGINEERING.

During the summer of 1887 a party of students of the College of Civil Engineering, under the direction of Mr. Raymond, ran a very careful line of levels from a bench-mark in San José to the summit of Mount Hamilton and return. The resulting height of the marble floor above half tide level of the Pacific Ocean was 4,209.5 feet, with a probable error of 0.007 foot. During June and July, 1888, Mr. Raymond, with a party of seven students, ran lines of levels from each of the four reservoirs to the Observatory, and to the Joaquin (Murietta) Spring; ran out the various roads on the reservation; located all the peaks by triangulation; and located a low-grade trail from the spring (Aquarius) to Joaquin's Spring. It is obvious that this work is directly valuable to the Observatory and to the students engaged in it; and it is indirectly of importance, as it connects the Observatory more closely to the University.

During June, 1888, I invited Professor Soulé to bring his advanced class in Astronomy (five Seniors) to the Observatory, and to remain there over night, which was done. Facilities of the same kind will be offered from time to time to students of various institutions in Santa Clara County.

PERSONNEL OF THE OBSERVATORY.

The Director is in charge of the thirty-six inch equatorial, and is responsible for the whole institution.

Mr. Burnham is in charge of all astronomical photography (assisted by Mr. Barnard), and he is also in charge of the twelve inch equatorial.

Mr. Schaeberle is in charge of the meridian circle, and observes with the thirty-six inch equatorial also.

Mr. Keeler is in charge of all spectroscopic work, of the time-service, and of the measuring engine.

Mr. Barnard is in charge of the six inch equatorial, of the photoheliograph, and of the comet seeker.

Mr. Hill is in charge of the library, of the secretary's office, of the meteorological observations, and does much of the work relating to the time-service.

INSTRUMENTS OF THE OBSERVATORY.

The Thirty-six inch Equatorial.

The great telescope consists essentially of three independent parts: (a) The visual objective, with the apparatus for micrometer measures; (b) the spectroscopic apparatus; (c) the photographic objective and appliances.

The first of these has been fully tested, and is amply proved to be practically perfect, under favorable conditions. Such conditions can usually be commanded in a great measure.

The spectroscopic apparatus has not yet been fully tested, for lack of time, but there is little doubt that it is entirely satisfactory.

We are now engaged in testing the photographic lens, and the results already obtained indicate that this, too, will be highly satisfactory.

The mounting of the large telescope is in nearly every essential respect very complete and convenient. The moving parts of the dome are perfect. The elevating floor has heretofore given some anxiety to the Lick Trustees. The changes which they have introduced have made it convenient in use, although a new one could be built materially better than the present structure.

The Twelve Inch Equatorial.

This very perfect instrument is in complete order. It is in charge of Mr. Burnham, and is assiduously used by Mr. Barnard when not employed by Mr. Burnham. Mr. Barnard has already discovered twenty-two nebulæ with it. He has also made a most important set of experiments, which have proved that it is an excellent photographic telescope. To make it fully useful in this respect a more powerful driving clock should be provided, slight changes are required in the slow-motion rods, and a more powerful finder should be added as a directing telescope during photographic exposures. Mr. Barnard has offered the Observatory the use of his five inch lens for this purpose.

The Portable Equatorial.

The mounting of this instrument was designed to take the six and one half inch objective of the south collimator of the meridian circle. As this objective is needed for use in the south collimator, at least for the present, the six inch objective of one of the three finders of the great telescope has been adapted to this mounting. The telescope is in charge of Mr. Barnard, and will be used for comet-seeking and for carrying a photographic wide-angle lens, with which it is hoped to do interesting and important work.

The Repsold Meridian Circle.

This splendid instrument is in perfect order. Mr. Schaeberle has begun the work of determining, with all the accuracy possible to modern science, the places of the fundamental stars by means of it. This work will extend over many years and will involve a very great number of subsidiary researches, such as an independent determination of our refraction, etc.

The Transit Instrument.

This instrument is regularly employed in the work of the time-service and is in good condition, except as to the verniers for the latitude circle. These are badly bent, but can be repaired when it is necessary to use this circle. It is in charge of Mr. Keeler, assisted by Mr. Hill.

The Comet-Seeker.

This intrument is in good condition, and is regularly used by Mr. Barnard (who has charge of it).

The Measuring Engine.

This instrument is in perfect order. It is in charge of Mr. Keeler, and will be used to measure astronomical photographs, to investigate micrometer screws, and for like purposes.

OBSERVATORY BUILDINGS.

The buildings of the Observatory proper, excluding the dome for the portable equatorial, are all in good condition, except that the chimneys require repairs, and a new roof of tin is required to replace the present slate roof. The dome for the portable equatorial requires a new foundation, and important, though inexpensive, repairs to its shutter, etc.

UNITED STATES COAST AND GEODETIC SURVEY.

The Chief of the United States Coast and Geodetic Survey has expressed his intention to run a line of levels of precision from the tide-gauge at San Francisco to the summit of Mount Hamilton during the summer of 1889. It is also designed by the Survey to make Mount Hamilton the primary station for longitude operations on the Pacific Coast. To this end the Survey desires to erect a small building on the plateau to contain the necessary instruments, permission to do which should first be granted by the Board of Regents. The Coast Survey observers will also determine a value of the latitude with their own instruments, which will be interesting as compared with independent determinations of our latitude to be made here by three different methods:

(*a*) By the meridian circle.
(*b*) By the zenith telescope.
(*c*) By prime vertical transits.

LIBRARY.

The library is sadly deficient in the necessary works of reference. It contains not more than two thousand volumes (exclusive of many hundred pamphlets), and has cost $4,645 82. Such a library as is needed here should contain about twenty thousand volumes. The binding is also very much in arrears.

One or two of its departments are, however, very complete, notably that of Catalogues of Stars. It will slowly and regularly grow by purchases of books and periodicals with the sum apportioned to it by the Regents, and by the valuable gifts of other Observatories and of Academies of Science, etc. We have to express our great obligations to the Smithsonian Institution, which transmits our own publications from Washington to foreign parts, and which forwards gifts to our library from foreign institutions, all without cost to the University.

TIME-SERVICE.

The time is regularly determined here, and is sent out at noon of every day (including Sundays) over the private wire of the Observatory to San José, and from thence over the lines of the Southern Pacific Company to every station as far east as Ogden and El Paso, and as far north as Portland.

VISITORS.

Visitors were received at night for the first time on July 14, 1888. Statistics of the attendance on such public nights, and of the daily number of visitors (compiled to include the visitors' night of August 18, 1888), are as follows:

Statistics of Visitors.

Total registered in the Visitors' Book:

June, 30 days	683 visitors.
July, 31 days	1,040 visitors.
August, 28 days	885 visitors.

Being 2,608 in 89 days, or an average of 29 daily.

Visitors' Nights:

(1.) July 14	40 visitors.
(2.) July 21	173 visitors.
(3.) July 28	105 visitors.
(4.) August 4	126 visitors.
(5.) August 11	157 visitors.
(6.) August 18	147 visitors.
(7.) August 25	149 visitors.

Being 897 on seven nights, or an average of 128 on each.

Probably these totals should be increased by 10 to 20 per cent, to include those persons who fail to register. For example, on the last of the above evenings one hundred and forty-nine registered, but one hundred and sixty-two were admitted to the floor of the seventy-five foot dome.

PUBLICATIONS OF THE LICK OBSERVATORY.

Volume I of the Publications of the Lick Observatory was printed by the State Printer, * * * [and] distributed by the Lick Trustees during 1888. The manuscript for Volume II is already partly prepared.

Respectfully submitted.

EDWARD S. HOLDEN.

Library and Art Collections.

To the President of the University of California:

Sir: For full details regarding the progress of the Library during the academic years 1886–7 and 1887–8, reference may be made to the Annual Reports of the Secretary of the University. A mere summary will here suffice.

ATTENDANCE.

The average all-day attendance of readers during the period in question has considerably increased from thirty-two in 1886, to forty-four in 1887, and forty-eight in 1888. When it is considered that the larger portion of the students, about three hundred in number, is engaged throughout the entire day in lecture, recitation, and laboratory work, the conclusion must be drawn that a very fair percentage of readers is obtained. As the Library is increased, it proportionately becomes more valuable for purposes of study and reference; and accordingly we note with pleasure an increasing use by scientists and others not connected directly with the institution.

GROWTH.

Besides pamphlets and maps, the Library contains thirty-seven thousand one hundred and ninety-nine bound volumes, of which, during 1886–88, were received—

By purchase	4,079 volumes.
By gift	925 volumes.
By binding of periodicals	282 volumes.
Total	5,286 volumes.

Pamphlets, numbering one thousand eight hundred and forty-nine, have been presented to the Library.

While in mere numbers this increase is below that of many a public library, in permanent and intrinsic or material value these five thousand volumes are worth, for purposes of reference and scholastic use, perhaps double the number of volumes added to the ordinary public library. Over two thousand volumes are comprised in sets of periodical literature and the transactions of learned societies acquired by purchase.

EXCHANGES.

One valuable means of increase is by exchange of publications with other Universities and with learned societies, and efforts to effect such exchange have been attended with success.

PUBLICATIONS.

Library Bulletins Nos. 8, 9, and 10 have been issued, as follows:

No. 8. References for Students of Miracle Plays and Mysteries, by Instructor Francis H. Stoddard, 1887. 67 pages.

No. 9. List of Printed Maps of California, by the Librarian, 1887. 33 pages.

No. 10. Cardinal Guala and the Vercelli Book, by Professor Albert S. Cook, 1888. 8 pages.

An appendix to No. 8, nearly as large as the Bulletin itself, is in preparation. Library Bulletin No. 1, being a list of periodical literature preserved in the principal libraries of this State, and issued in 1880, has been long out of print. It would be advisable to issue a new and greatly enlarged edition.

The topical Contents-Index of the Library has been revised for publication, which is earnestly recommended.

WANTS.

The chief want of the Library is an adequate endowment. The Reese Fund income, amounting to about $3,000 annually, is wholly inadequate to purchase the books which are urgently needed for use at the present time, and a sum of four times this amount could be expended judiciously every year. Future growth of the University will bring into prominence other departments of knowledge and research, and a corresponding expansion of library facilities for work in these branches will have to be made. The fact that our book purchases are made under recommendation of a Faculty acting in the capacity of a Board of Experts; that our acquisitions are carefully catalogued, safely kept, and diligently used; that every dollar expended upon books may be considered as laid out upon permanent improvements—should sufficiently warrant a large augmentation of our book funds. Before this great want other needs of the Library seem insignificant.

Respectfully submitted.

J. C. ROWELL,
Librarian.

MUSEUM.

To the President of the University of California:

SIR: In answer to your request, I beg to report that the annual donations to the Museum from the public continue to be liberal.

During the past two years the remainder of the material purchased by the legislative appropriations of 1884 has been received, which, for want of proper space and case-room, is but temporarily placed. The three thousand fossils belonging to this collection are worth displaying, but the overcrowded condition of the Museum precludes such a desirable result, for the space required for Palæontology alone would demand a hall equal to our largest.

Classes from the public and private schools of San Francisco and Oakland have visited the Museum at frequent intervals during the past ten years, but those in charge of the pupils frequently write before coming, inquiring what number can be received at any one time. This caution resulted from the teaching of former visits, when they learned of our inadequate accommodations.

Five cabinets have been added since the arrival of these later collections, and the increased storage afforded by the cabinets enabled us to make the Museum somewhat clear in its passageways.

For five years the Museum has had its heating appliances cut off, and the collections have been without the preserving influence of artificial heat, and I wish particularly to bring to your notice that organic tissues cannot be kept from decay in a damp atmosphere. Then, there arises discomfort to visitors and loss of health to those in charge.

Respectfully submitted.

J. J. RIVERS,
Curator.

PROFESSIONAL COLLEGES.

Hastings College of the Law.

To the President of the University of California:

Sir: I have the honor to submit to you the following report concerning the Law Department of the University:

Since the report of the Dean of this College to the President of the University two years ago, two classes have graduated, the first numbering twenty-one members; the last, twenty-five. Several of these graduates had previously been admitted to practice by the Supreme Court of this State. The remainder were admitted on motion, in accordance with the provisions of the Act establishing the College. The class of 1887 was the smallest of the eight classes which have graduated. The classes of 1886 and 1888, which numbered exactly the same, were next in size. The increased severity of the entrance examinations has lessened the number of students, and will consequently lessen the number who will graduate in the future. The present Senior class has fifteen members; the Middle class, twenty; and the Junior class, about thirty;—about one half as many, respectively, as attended four years ago. These figures do not, of course, represent all who have been members of the classes, but only those who have not been rejected, or who have not voluntarily withdrawn.

In August, 1886, the Board of Directors of the College raised the standard of admission to about the same as is required to enter the Literary Course at Berkeley; and, therefore, unless an applicant is a graduate of some recognized College or University, or of one of the accredited High Schools of the State, he is compelled to pass a satisfactory examination in English, Arithmetic, Algebra, Geometry, History, Geography, and Latin. No other similar institution in the country requires more, or even as much.

The propriety of severe conditions for admission to law schools has been much discussed by those interested in legal education. It should be remembered that these institutions are not the only avenues to the profession, but that the larger proportion of those entering upon the practice of the law come from lawyers' offices, without a law school education. The Supreme Court of California, for example, admits annually four times the number of those who graduate from the Hastings Law School; and the proportion is probably about the same in other States where the distinction, in admission to the bar, between those who have graduated from law schools and those who have not is maintained. The average Supreme Court examination can be passed with ease on the limited amount of knowledge which it is possible to acquire in a year's preparation.

Were it not for this fact, law schools could exact higher entrance qualifications than they do. But there is danger that raising the standard too high, under existing circumstances, may deprive of the advantages of a systematic legal training many who *will* enter the legal profession, and who most need such a training. On the other hand, if too low a standard is maintained, persons may be encouraged to take up the study of the law who are entirely unfitted for it. The importance of the step taken in this direction by the Directors of this College is therefore apparent.

The result has been, in the main, satisfactory. While many have been prevented from entering the College, at least for the time being, the average scholarship has been materially raised. Certainly, one intending to become a lawyer should have at least the amount of preliminary training represented by the required studies.

The Law College, through its earnest endeavors, is overcoming the early opposition to it. The public interest in it has been increased by the recent selection, as its chief instructor, of Hon. E. W. McKinstry, whose extensive learning and large experience as a jurist and legislator eminently fit him to occupy the chair of his illustrious predecessor, John Norton Pomeroy.

The appointment of Judge McKinstry has brought about some changes in the methods of instruction. Formal lectures are almost entirely done away with and text-books and cases substituted, with better results. All the real work of the College devolves upon Judge McKinstry and Assistant Professor Slack. The income does not permit of any additional aid, which could be used with advantage in extending the course and making it more complete and satisfactory.

Respectfully submitted.

ROBERT P. HASTINGS,
Dean of the Faculty of Law.

Toland Medical Department.

To the President of the University of California:

Sir: During the year ending November 30, 1888, the total number of students registered was seventy-three, the largest class in the history of the college.

Of these, thirty-six registered for the first time. The Senior class numbered eighteen, the Junior class twenty-three, the Freshman class thirty-one, and there was one post-graduate student.

Of the eighteen in the Senior class, eleven were recommended to the Board of Regents for the degree of Doctor of Medicine, three were rejected, and four withdrew.

The school still occupies the property donated to the University by the late Dr. H. H. Toland, and each year the inconvenience of the location, and the unfitness of the building for the modern methods of medical instruction, become more apparent.

The condition of the building is so poor that a large part of the income of the school has to be expended each year for repairs, and it is impossible for the Faculty to provide laboratories and other facilities suitable to the needs of the classes.

The recent purchase by the Board of Regents of the lots on Potrero Avenue, opposite the City and County Hospital, gives the University the finest location in the city for a medical school, and it is earnestly hoped that means will in some way be provided by which a building can be erected.

Respectfully submitted.

R. A. McLEAN,
Dean of the Medical Faculty.

COLLEGE OF DENTISTRY.

To the President of the University of California:

SIR: Your favor of October twenty-second, requesting a report on the changes in the College of Dentistry within the past two years and its most pressing needs at present, is at hand.

In the Faculty proper there have been two changes. In December, 1887, S. W. Dennis, M.D., D.D.S., Professor of Operative Dentistry and Dental Histology, resigned, and L. L. Dunbar, D.D.S., was appointed to the position thus made vacant. M. W. Fish, M.D., Professor of Physiology, also resigned at the same time, and A. A. D'Ancona, A.B., M.D., was appointed to fill the vacancy.

This College was the second Dental College in the United States to adopt a nine months' course of instruction, the third to require a preliminary examination, and the third to require three years' study of dentistry before graduation. The National Association of Dental Faculties has induced other Colleges to increase their requirements, so that now about half of them require three years' study, instead of two, before graduation; and five or six have increased their courses of lectures from five to nine months.

As in our last report, the wants of the College may be summed up in two words, "room and money," but these wants are now more pressing than ever. Although the College has been generously provided with clinic rooms by the Medical Department of the University, and has been allowed free use of the medical lecture rooms, the need of larger clinic rooms becomes more and more apparent. The operating rooms should be so arranged that the patients can enter at one door and the students at another, as the use of the same halls and entrances by both leads to confusion and loss of time.

A larger reception room is needed for patients; also, an examination room and an extraction room. The dental laboratory, while as convenient as possible for its size, has proved too small, and part of one of the halls has been utilized as an additional laboratory. A study room for students not actually at work would prove a great convenience and prevent the crowding of operating rooms and laboratory.

If the College were more centrally located it would enable the professors, demonstrators, and instructors to attend to their duties with much less loss of time, and also enable the College to secure the occasional service of other desirable men who cannot now spare the time. A more central location would also increase the clinical facilities of the College.

The only remuneration now received by the professors is the small amount left over from the tuition fees after paying the college expenses. During the whole seven years since the College started, this remuneration has amounted to only $500 for each professor. In consequence of this each one is dependent on his private practice for an income, and cannot give as much time as is desirable to his college duties.

Although we have reason to be proud of the results already attained, increased facilities would give still more satisfactory results.

Respectfully submitted.

C. L. GODDARD,
Dean of the Dental Faculty.

College of Pharmacy.

To the President of the University of California:

Sir: In reply to your letter of the twenty-sixth instant, I herewith submit the following regarding the Department of Pharmacy of the University of California:

The sixteenth annual session has just closed. Thus far in the history of this Department, one hundred and forty-two persons have taken the diploma of "Graduate in Pharmacy." Since my last report, the classes have increased materially in numbers. The requirements for a preliminary examination for entrance to the lectures, while possibly reducing to some extent the number of matriculants, have to a considerable degree given us a more intelligent and satisfactory class of students, as the results of the examination prove. In fact, the attendance this year is larger than ever before.

This Department of the University is in very great need of a laboratory equipped for practical instruction in pharmaceutical work. Indeed, something in this direction must be done at once. This College is the only one in the United States that is deficient in this respect, and students from California are attending eastern Colleges because we do not provide suitable laboratory instruction. Apparatus, etc., that would cost only a few hundred dollars would be of great benefit to us in this direction. The only change in the Faculty during the past two years was the appointment of William M. Searby as Professor of Materia Medica, in place of Frederick A. Grazer, resigned.

Respectfully submitted.

EDWARD W. RUNYON,
Dean of the Pharmaceutical Faculty.

LIST OF PUBLISHED WRITINGS OF OFFICERS OF THE UNIVERSITY, 1886 TO 1888.

[NOTE.—In a few cases, the publications here mentioned are of date prior to 1886; most of these were not included in the lists published in the Biennial Report of the President, 1886.]

WINSLOW ANDERSON, M.D., Assistant to the Chair of Materia Medica and Medical Chemistry.

On the Mortality of Diphtheria.—*The Medical Record* for June, 1886, vol. XXIX, p. 740.

Report of Alumni Association of the Medical Department of the University of California.—*Pacific Medical and Surgical Journal*, 1886, vol. XXIX, pp. 302–303.

Western Mummies.—*Science* (N. Y.), September 23, 1887; vol. X, no. 3, pp. 146–7–8.

Morphio-Mania.—*Medical Record* (N. Y.), Nov. 5, 1887; vol. XXXII, p. 595.

Prescription Writing.—*Medical and Surgical Reporter* (Philadelphia), October 15, 1887; vol LXII, no. 16. pp. 510–11–12–13.

Impacted Biliary Calculus.—*Pacific Medical and Surgical Journal and Western Lancet* for March, 1887; vol. XXX, pp. 148–51.

Results of Vaccination (over 5,000 cases).—*Pacific Medical and Surgical Journal* for March, 1888, vol. XXXI, pp. 143–4.

A Description of the Desiccated Human Remains in the California State Mining Bureau.—Bulletin No. 1, May 1, 1888. J. D. Young, Superintendent State Printing, Sacramento, Cal.

Minor newspaper articles.

In preparation, Mineral Springs of California.

WILLIAM DALLAM ARMES, Ph.B., Instructor in English.

A Forgotten Poet.—*Californian*, III, 180.

The Book Exhibition at Berkeley.—*Overland Monthly*, second series, IV, 102.

Hawthorne and the Hawaiian Premier.—*The Critic*, VIII, new series, 165.

"A Divided Heart."—*The Critic*, X, new series, 208.

Second-hand Erudition.—*The Nation*, XLIII, 32.

Repeal the Tariff on Books.—*The Nation*, XLV, 251.

A series of letters on the resources of Alaska, in the San Francisco *Evening Bulletin*, travel sketches and letters in that paper, the San Francisco *Chronicle*, the San Francisco *Call*, and the student papers, the *Berkeleyan* and the *Occident*, and notes on literary matters in the *Critic* and the *Literary World*.

WASHINGTON AYER, M.D., Professor of Hygiene.

Public Hygiene and State Medicine.

EDWARD EMERSON BARNARD, Astronomer.

1. In the Astronomische Nachrichten, Kiel, Prussia.

No. of A. N.	Page of A. N.	Title or Subject of Article, Etc.
2,756	323	Ring Micrometer Observations of Comets and Nebulæ.
2,773	203	Ring Micrometer Observations of Comet *b* 1887.
2,776	251	Ring Micrometer Observations of Comets.
2,788	57	Ring Micrometer Observations of Comet IV, 1887.
2,788	59	Orbit of Comet III, 1887.
2,799	243	Ring Micrometer Observations of Comet IV, 1887.
2,804	327	Observations of Olber's Comet of 1815.
2,805	337	Ring Micrometer Observations of Winnecke's Periodic Comet.
2,819	173	On a Supposed Observation of Comet I, 1887, by Swift.
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VII	41	Notes on Comet *f* 1886.
VII	63	Ring Micrometer Observations of Comets.
VII	79	Ring Micrometer Observations of Comets.
VII	95	Elements of Orbit of Comet *d* 1887.
VII	99	Ring Micrometer Observations of Comet IV, 1887.
VII	111	Ring Micrometer Observations of Comet IV, 1887.
VII	126	Ring Micrometer Observations of Comet IV, 1887.
VII	127	Ring Micrometer Observations of Comet *f* 1887.
VII	186	Observations of the Zodiacal Counter Glow.
VIII	64	Observation of the Occultation of 47 Libræ by Jupiter.
VIII	108	Discovery and Observations of Comet *e* 1888.
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V	275	Note on the Discovery of a New Comet.
V	286	Note on the Nebula, G. C., 4594.
V	288	Note on Winnecke's Periodic Comet.
V	310	Note on Comet *f* 1886.
VI	114	Note on the Discovery of a New Comet.
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3	The binary star, β Delphini	Monthly Notices R. A. S.	XLI	—
4	New double star, α Aurigæ	Observatory	III	451
5	The multiple star, P. XXIII, 100 (*O* Σ 496)	Observatory	III	568
6	Notes on double stars	Observatory	III	408
7	New double star, 5 Persei	Observatory	III	582
8	ζ Lyræ	Observatory	IV	18
9	40 Leonis Minoris, new double star	Astronomical Register	XVIII	140
10	New double star, 9 Persei	Astronomical Register	XVIII	286
11	New double star, Σ 2318	Astronomical Register	XVIII	113
12	The double star, Σ 2789	Astronomical Register	XVIII	286
13	ψ' Aquarii	Astronomical Register	XIX	41
14	Measures of the Companion of Sirius	Astronomische Nachrichten	No. 2314	
15	The double star, 85 Pegasi (β 733)	Astronomische Nachrichten	Nos. 2319–2334	
16	ζ Sagitarii	Astronomische Nachrichten	No. 2338	
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ADOLPH HANS WEBER, Ph.B., Met. E., Temporary Assistant in the United States Agricultural Experiment Station.

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FINANCIAL STATEMENTS.

Statement of expenditure of the State University Fund, as directed in an Act of the Legislature of the State of California, entitled "An Act to provide for the permanent support and improvement of the University of California, by the levy of a rate of taxation, and the creation of a fund therefor." [Approved, 14 February, 1887.]

1888.		Dr.	Cr.
March 1	By cash on Controller's warrants		$56,000 00
May 31	By cash on Controller's warrants		20,580 79
July 23	By cash on Controller's warrants		5,962 64
June 30	To C. L. Crisman, U. S. Experimental Station Building	$738 32	
Aug. 15	To C. L. Crisman, U. S. Experimental Station Building	2,500 00	
Sept. 13	To C. L. Crisman, U. S. Experimental Station Building	700 00	
Sept. 13	To H. A. Palmer, land for reservoir	20,000 00	
Oct. 13	To C. L. Crisman, U. S. Experimental Station Building	2,496 54	
	To amount reserved for the purpose of constructing a new chemical laboratory	56,108 57	
	Totals	$82,543 43	$82,543 43

Statement of Expenditure of Agricultural Experiment Station Fund.

1888—March 16—To E. W. Hilgard, traveling expenses in discharge of duty	$19 95
March 31—To E. J. Wickson, salary for month of March	200 00
March 31—To K. McLennan, salary for month of March	70 00
March 31—To F. W. Morse, salary for month of March	100 00
March 31—To M. E. Jaffa, salary for month of March	100 00
March 31—To G. E. Colby, salary for month of March	75 00
March 31—To A. H. Weber, salary for month of March	100 00
April 5—To labor, as per March payroll	748 30
April 5—To H. McCaskell Company, blacksmithing	16 35
April 5—To San Francisco "Chronicle," advertising	27 85
April 5—To Union Box Factory, fifty double crates with baskets	21 50
April 5—To J. J. Evans, stationery	22 75
April 5—To Alexander Filipello, making cuttings on University plot	30 62
April 5—To Alexander Filipello, hire of wagon and horse	2 50
April 5—To Justin. Caire, chemicals and apparatus for Experimental Station	128 40
April 5—To Dewey & Co., bulletins	9 00
April 5—To O'Connor, Moffat & Co., twenty yards sheeting	5 50
April 30—To E. J. Wickson, salary for month of April	200 00
April 30—To K. McLennan, salary for month of April	70 00
April 30—To F. W. Morse, salary for month of April	100 00
April 30—To M. E. Jaffa, salary for month of April	100 00
April 30—To Geo. E. Colby, salary for month of April	75 00
April 30—To A. H. Weber, salary for month of April	100 00
May 9—To Labor, as per April payroll	689 75
May 9—To the "Examiner," advertising	74 65
May 9—To San Francisco "Chronicle," advertising	71 75
May 9—To K. F. Warfield, grape cuttings	29 00
May 9—To Joseph McClain, fifty gallons coal oil	12 50
May 9—To H. L. Whitney, excavation and brick work for Experimental Station Building	1,644 35
May 9—To Mrs. Chas Krug, grape cuttings	23 87
May 9—To Patterson & Co., expressage	11 00
May 9—To Henry Maloon, moving old viticultural laboratory	195 00
May 9—To Wells, Fargo & Co., expressage	2 55
May 9—To E. W. Hilgard, traveling expenses in discharge of duty	21 25
May 9—To J. Muir, grape cuttings	6 00
May 9—To L. Fowler, grape cuttings	2 00
May 9—To Felix Gillet, grape cuttings	3 00
May 9—To R. Meyer, car fare to and from Piedmont	1 10
May 9—To Wells, Fargo & Co., expressage	1 25

1888—May 9—To Neville & Company, five hundred sample sacks	$8 75
May 9—To Klinkner & Co., one rubber stamp	1 00
May 9—To E. W. Hilgard, traveling expenses in discharge of duty	12 50
May 9—To Wells, Fargo & Co., expressage	12 10
May 9—To R. D. Fearey, altering watering pot	1 00
May 9—To M. E. Jaffa, traveling expenses	2 30
May 9—To Wells, Fargo & Co., expressage	42 45
May 9—To Trumbull & Beebe, one thousand tree labels	1 00
May 9—To Justinian Caire, padlocks, etc.	5 45
May 9—To E. W. Hilgard, traveling expenses in discharge of duty	25 10
May 9—To Wells, Fargo & Co., expressage	19 39
May 9—To the "Examiner," advertising	37 50
May 9—To E. Denny & Co., one dozen sheets cross sections	60
May 31—To E. J. Wickson, salary for month of May	200 00
May 31—To K. McLennan, salary for month of May	70 00
May 31—To F. W. Morse, salary for month of May	100 00
May 31—To M. E. Jaffa, salary for month of May	100 00
May 31—To G. E. Colby, salary for month of May	75 00
May 31—To A. H. Weber, salary for month of May	100 00
June 30—To E. J. Wickson, salary for month of June	200 00
June 30—To K. McLennan, salary for month of June	70 00
June 30—To F. W. Morse, salary for month of June	100 00
June 30—To M. E. Jaffa, salary for month of June	100 00
June 30—To G. E. Colby, salary for month of June	75 00
June 30—To A. H. Weber, salary for month of June	100 00
June 30—To labor, as per May payroll	599 03
June 30—To labor, as per June payroll	507 75
June 30—To F. W. Krogh & Co., one Economy horse-power and one No. 2 triple-acting irrigating pump and fittings	178 65
June 30—To J. D. Lindner, grubbing ninety-four trees, at $3	282 00
June 30—To C. L. Crisman, first payment, as per contract, for construction of building at Berkeley	1,061 68
June 30—To J. D. Layman, clerical work	13 00
June 30—To A. T. Cotton, galvanized casing, etc., for well	47 45
June 30—To J. D. Lindner, building fence	136 50
June 30—To John Hambleton, boring well	60 00
June 30—To Clinton Day, architect's commission	82 22
June 30—To W. G. Raymond, survey of Amador Station	75 00
June 30—To Congdon & Co., coal oil, etc.	15 55
June 30—To G. G. Wickson & Co., one Remington type-writer	97 50
June 30—To G. G. Wickson & Co., one drawer desk	17 50
June 30—To J. Schultzbach, four rain gauges	21 60
June 30—To Oakland Gaslight and Heat Company, four thousand five hundred cubic feet gas	12 40
June 30—To Patterson & Co., expressage	12 50
June 30—To W. G. W. Harford, for board of men at Piedmont	5 10
June 30—To Joseph McKeown, car fare to and from Piedmont	1 10
June 30—To James Stutt, car fare to and from Piedmont	1 10
June 30—To H. McCaskell, blacksmithing	10 50
June 30—To Dewey & Co., bulletins	9 00
June 30—To J. G. Wright, twelve sacks and twenty-five pounds rope	2 50
June 30—To E. W. Hilgard, traveling expenses in discharge of duty	23 40
June 30—To Wells, Fargo & Co., expressage	11 20
June 30—To P. Blakiston, Son & Co., books for laboratory	9 94
June 30—To John Wiley & Sons, books for laboratory	8 47
June 30—To Gladding, McBean & Co., tiles	125 60
August 15—To Bull & Grant Farm Implement Company, three harrows	87 00
August 15—To Baker & Hamilton, tools for stations	177 30
August 15—To J. Carie, colorimeter	15 00
August 15—To James Stanley, one Compton gate	17 50
August 15—To J. D. Mason, building cistern and material	117 40
August 15—To E. Ginocchio & Bro., provisions for laborers	8 75
August 15—To E. Ginocchio & Bro., wire, staples, and wheelbarrow	63 51
August 15—To W. L. Fortner, labor, building cistern	69 00
August 15—To N. Trabucco, timber on tract donated to Experimental Station	50 00
August 15—To L. Newman & Co., six barrels cement	42 00
August 15—To A. French, three hundred posts	37 50
August 15—To Luigi Cumo, labor, building fence and reservoir	36 00
August 15—To R. Johnson, labor, building fence and reservoir	30 62
August 15—To F. Mace, lumber	23 77
August 15—To George Mellas, labor, building fence and cistern	14 00
August 15—To A. Caminetti, buggy hire, etc.	9 00
August 15—To S. W. Bright, meat for laborers	3 40
August 15—To T. J. Clapp, building fence	80 00

1888—August 15—To San Joaquin Lumber Company, lumber	$580 53
August 15—To Woodin & Little, hose and couplings	119 14
August 15—To D. D. Shaff, labor in obtaining water for analysis	2 50
August 15—To F. M. Schultz, one hundred and sixty-five pounds nails	8 00
August 15—To C. Dunning, one keg nails	4 50
August 15—To San Francisco Chemical Works, nitric, muriatic, and sulphuric acids	28 17
August 15—To California Furniture Manufacturing Company, furniture for laboratory	129 00
August 15—To Hawley Bros. Hardware Company, tools for stations	589 56
August 15—To F. Korbel & Bros., two small tanks	22 00
August 15—To Southern Pacific Milling Company, lumber and nails	607 18
August 15—To Justinian Caire, supplies and apparatus for laboratory	116 35
August 15—To Henry W. Taylor, lumber	83 24
August 15—To J. H. Holden, kegs	109 25
August 15—To H. McCaskell & Co., blacksmithing	13 05
August 15—To N. B. Byrne, postage stamps	15 00
August 15—To Bausch & Lomb Optical Company, microscope and accessories	223 60
August 15—To California Pottery and Terra Cotta Company, flower pots	101 00
August 15—To Truman, Hooker & Co., plows and harness	156 70
August 15—To Payot, Upham & Co., stationery	24 00
August 15—To Henry J. Green, four anemometers	94 00
August 15—To C. D. Harvey, heating apparatus	400 00
August 15—To Neville & Co., three cots	15 00
August 15—To West Coast Furniture Manufacturing Company, furniture for laboratory	103 50
August 15—To M. H. Bailey, hauling lumber	17 60
August 15—To Herbert R. Spencer & Co., accessories to microscope	210 00
August 15—To Oakland Gaslight and Heat Company, gas	52 80
August 15—To Standard Soap Company, three bottles refined glycerine	5 40
August 15—To San Francisco Gaslight Company, ammonia	8 00
August 15—To Dewey Engraving Company, electrotypes	7 50
August 15—To Pacific Saw Manufacturing Company, one six-foot cross cut saw	6 00
August 15—To Hicks & Judd, binding three sets report	2 70
September 15—To Justinian Caire, supplies for laboratory	75 03
September 15—To Justinian Caire, madder root	7 50
September 15—To Justinian Caire, two barometers, etc.	130 88
September 15—To Justinian Caire, thermometers, etc.	57 85
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Less	7 40
	$15,000 00

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